Minutes of the 6th meeting of Joint Working Group of SAFIR "To Study, Formulate and Recommend for Facilitating Power Trade Development in South Asia"

Date: 06th December, 2021 at 04:00 PM IST on MS Teams

List of participants: Appendix-I

Deputy Chief (Regulatory Affairs) Central Electricity Regulatory Commission (CERC), India welcomed all members to the sixth meeting (virtual) of SAFIR Joint Working Group (JWG) on the said subject and provided a brief on the agenda of the meeting.

Agenda 1: Confirmation of minutes of the 5thmeeting of the JWG

Deputy Chief (RA), CERC apprised the members about the agenda items which were discussed and the action points identified in the 5th meeting of the JWG held on 03.09.2021.Thereafter, the minutes of the 5th meeting of JWG were confirmed.

Agenda 2: Harmonization of Rules and Common Minimum Grid Code - Status update by IRADe

IRADe was requested to present the status of the study. Sharing the presentation(Annexure-**I**),Director, IRADeinformed JWG that inaccordance with the suggestion of the JWG, IRADeapproached POSOCO, Bangladesh and Nepal,for discussingthe report and to obtain their suggestions/ comments.Accordingly, POSOCOhas submitted their comments which are incorporated in the presentation

After discussions, the following was decided:

1. The next meeting can be held by inviting the technical experts, officials of the system operators and Electricity Authority at an appropriate level in the respective SAFIR member countries so that the technical aspects are discussed in greater detail
2. As the precursor for the above meeting, IRADeshould list out the aspects on which there is consensus amongst the participating countries and the aspects on which the views are divergent so that constructive discussions can be held during the meeting.
3. Respective RegulatoryCommissions of the member countries need to assist SAFIR Secretariat organize the above meetings

Agenda 3: Power Market Design for facilitating electricity trade among SAFIR member countries - Status update by the World Bank

The representative of World Bank was requested to provide an update on the study. Mr DebChatopadhyay, World Bank made a presentation **(Annexure-2)**on the overview of the South Asian Regional Energy Market framework design, the benefits the market would bring to member countries and listed the following three envisaged next immediate steps as:

1) Feedback on the proposed short, medium- and long-term action steps (2-3 weeks)
2) Develop a ToR for developing a road map. (within 6 weeks – say mid-January, 2022)
3) Engaging a consulting firm to develop the steps in details

After discussions, the following was decided:

1. World Bank proposed initiating a study which would list out a roadmap as also engage with various stakeholders in each member country of SAFIR.

2. The JWG appreciated the proposal and decided that while the short term and medium-term steps can be initiated, World Bank can also assist each SAFIR country for enabling inter-country and intra-country dispatch optimisation by carrying out a pilot study. The JWG also requested World Bank to include a component of capacity building in their study.

3. The decisionw.r.t. participation in Cross border trade or SAREM would be taken by respective Governments of the respective countries based on the findings of the study.

The meeting ended with a vote of thanks to the Chair.

Appendix - I

Listof participantsof the 6th meeting (virtual) of SAFIR Joint Working Group (JWG) "To study, formulate and recommend for facilitating Power trade development in South Asia" held on 06th December 2021 at 04:00 PM IST

S. No.	Name & Designation	Organisation
	MEMBERS	
01	Mr. SamdrupThinley, Chairperson/CEO	JWG/ BEA, Bhutan
02	Mr. Mohammad Bazlur Rahman, Member	BERC, Bangladesh
03	Mr. DilliBahdur Singh, Chairman	NERC, Nepal
04	Mr. I. S. Jha, Member	CERC, India
05	Dr. S K Chatterjee, Chief (Regulatory Affairs) and Convenor	CERC, India
	SPECIAL INVITEES	
06	Mr. RV Shahi, Sr. Energy Advisor	World Bank, Europe
07	Mr. Pankaj Batra, Project Director	SARI/EI, IRADe, India
08	Mr. GaminiHerath, Deputy DG	PUCSL, Sri Lanka
09	Mr. Kanchana Siriwardena, Director Tariffs & Economic Affairs	PUCSL, Sri Lanka
10	Mr. Nalin Edirisinghe (Director Licensing)	PUCSL, Sri Lanka
11	Mr. ChalithPasindu, Assistant Director	PUCSL, Sri Lanka
12	Mr. Firoz Zaman, Deputy Director,	BERC, Bangladesh
13	Mr. B.M. Mizanul Hassan, SE	PGCBL, Bangladesh
14	Mr. Monzurul SE	NLDC, Bangladesh
15	Mr. Sahbun	PGCB, Bangladesh
16	Mr. Irfan Yousuf, Advisor	NEPRA, Pakistan
17	MrDebabrata Chattopadhyay, Senior Energy Specialist	World Bank
18	Mr Salman	World Bank
19	Mr. Waleed Saleh I. Alsuraih, Lead Energy Specialist	World Bank
20	Ms. Maitreyi Karthik	SARI/EI, IRADe, India
	SAFIR SECRETARIAT	
21	Ms. Rashmi SomasekharanNair, Deputy Chief	CERC, India

	(Regulatory Affairs)	
22	Mr. Sanjeev Tinjan, Asstt. Chief (Regulatory Affairs)	CERC, India
23	Mr. Ravindra Kadam, Advisor (RE)	CERC, India
24	Mr. Saurabh, Principal Research Officer (Regulatory Affairs)	CERC, India
25	Mr. Manvendra Pratap, Research Officer(Regulatory Affairs)	CERC, India

South Asia Regional Initiative for Energy Integration

Presentation

on

Harmonisation of Rules and Common Minimum Grid Code (CMGC) for South Asia

Presented by

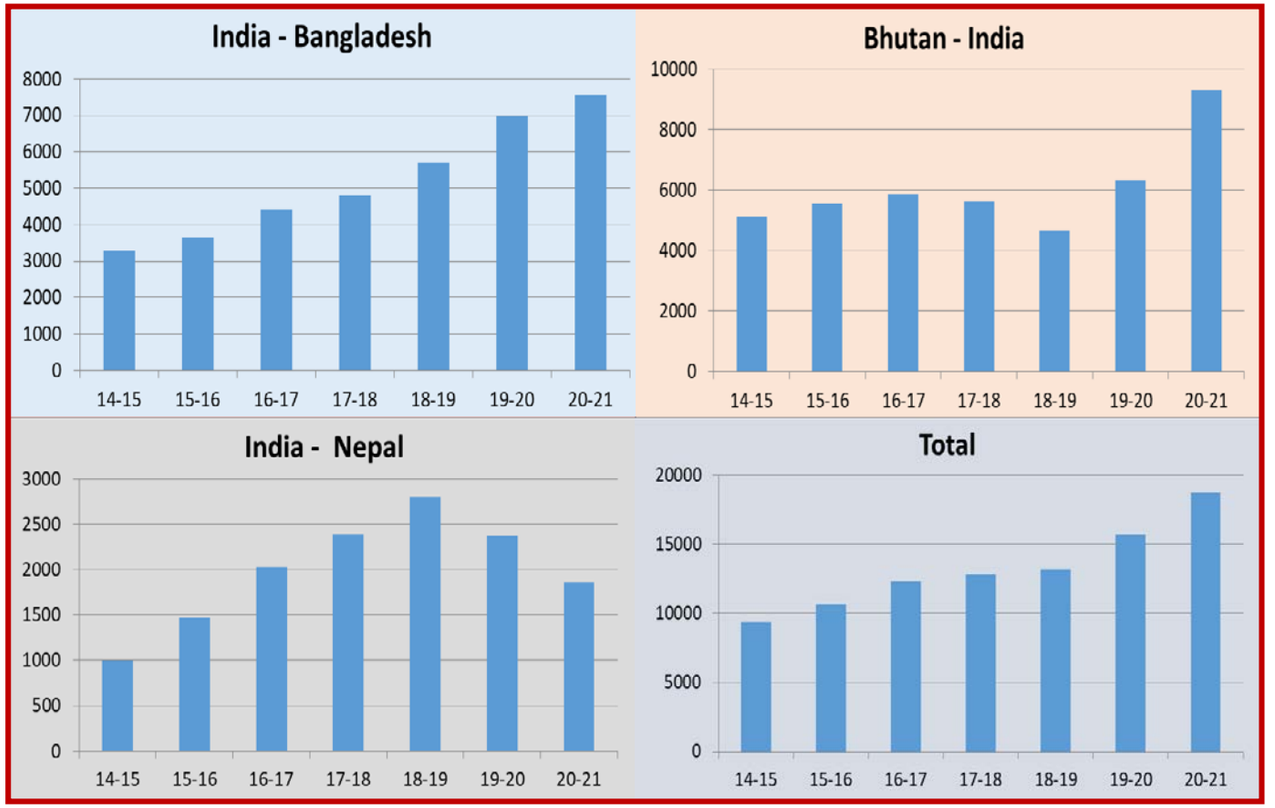
Mr. Pankaj Batra

Project Director, SARI/EI/IRADe

6th meeting of the Joint Working Group(JWG) of SAFIR "To study, formulate and recommend for facilitating Power trade development in South Asia" (Virtual Meeting), 4 PM IST onwards , through Video conferencing, Monday , 6th December 2021.

Growth of Cross Border Electricity Trade in BBIN Region during last 6 Years * (GWh)

Year	India - Bangladesh	Bhutan - India	India - Nepal	India- Myanmar	Total
14-15	3271	5109	997	-	9377
15-16	3654	5557	1469	-	10680
16-17	4419	5863	2021	3.23	12306
17-18	4808	5611	2388	5.07	12812
18-19	5690	4657	2798	6.67	13152
19-20	6988	6310	2373	8.67	15671
20-21	7551	9318	1865	9.24	18734



Bangladesh – HVDC Connections:
HVDC B-t-B Pole 1 – October 13
132 KV Tripura- Comilla – April 16
HVDC B-t-B Pole 2 – July 18

Bhutan - Commissioning of Mangdechhu (4*180 MW):
Unit 1: June 19, Unit 2 : July 19
Unit 3: Aug. 19, Unit 4 : Aug. 19

Nepal - Commissioning of 400 KV Muzaffarpur – Dhalkebar Line
Charging of Line at 132 KV : Feb 16
Charging of Line at 220 KV : Aug 18
Charging of Line at 400 kV : Nov 20

* The values of Energy trade have been obtained from NLDC (POSOCO) Reports and each Year is Financial Year ranging from 1st April -31st March

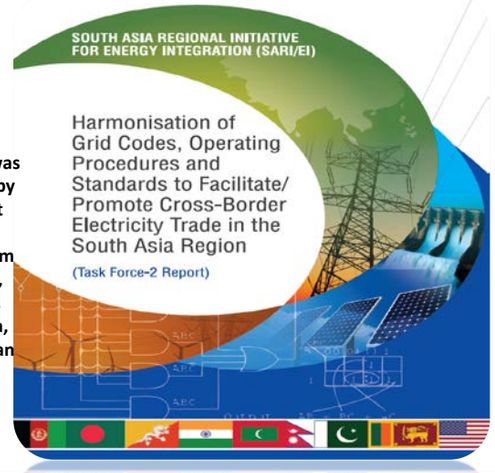
Contents

Need for Harmonisation Rules and SARI/EI Past Work

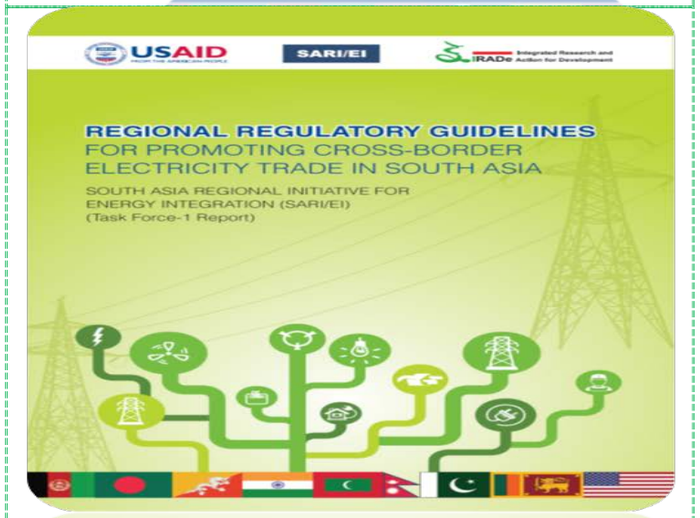
Need for Harmonization of Rules, Grid Codes and SARI/EI Past Work

- South Asia (SA) countries are at different stage of power sector evolution in terms policy, regulatory and legal frameworks.
- Any regional market design will need to have some basic **technical rules** to be commonly followed by the SA countries for market to function smoothly in a transparent , fair and competitive manner.
- SARI/EI has recognized this need a long time back, worked on many areas to related harmonization of policy, legal and regulatory framework among SA countries over last 8 years.
- Earlier published **regional regulatory guidelines** and as well as comprehensive report on **Harmonization of Grid codes, Operating Procedures and Standards to facilitate/promote Cross-Border Electricity Trade** in the South Asia Region-Framework Grid Code Guidelines.
- By building upon the past work and taking forward various initiatives, we have developed The **Common Minimum Grid Code for South Asia**.

Task Force-2 Report on Harmonisation of Grid codes, Operating Procedures & Standards to facilitate/promote CBET in South Asia Region



Task Force-2 was represented by Government Nominated Members from Afghanistan, Bangladesh, Bhutan, India, Nepal, Pakistan & Srilanka.



Comments of POSOCO on the Common Minimum Grid Code (CMGC) for South Asia

SL no	POSOCO Comments	SARI/EI/IRADe Response
1.	**General Comments** i) It is suggested that instead of attempting to draft a common minimum grid code, a guideline on common minimum requirements of grid codes of the countries concerned may be thought of.	**This would be moving a step backward. The JWG may like to take a view.**
2.	**Comments** The harmonious grid reliability in the region has to be ensured through robust institutional arrangements at all levels. These institutions have to be first recognized by the respective governments with adequate statutory support. The agencies/organisations which are expected to be provided with responsibility in Grid Code need to be covered under **separate chapter on 'Roles of agencies/organisations and their Linkages'. The set of responsibilities need to be mentioned against each such organisation clearly.**	**Clause 3(e) –** **The CMGC for South Asia must give equal opportunities for all South Asian nations. The purpose of putting this was that Cross Border Electricity trade (CBET) should not wait till the various South Asian Forums, i.e. the Forum of Regulators, the Forum of Planning Agencies, the Forum of System Operators, the Forum of Transmission Utilities are formalized. The CMGC is a technical document and grid security is uppermost during CBET. Therefore, this is an interim arrangement only. In India too, it has diverse stakeholders, with their own interests, i.e. the Central Government, the State Government and privately owned generators and transmission licensees. Therefore, this document is made to have a level playing field for all these players. Since these systems are already in place, it was thought that this could start with the existing arrangement. The roles of respective forums will be clearly spelled out.**

SL no	POSOCO Comments	SARI/EI/IRADe Response
1.	**Comments** The **Planning guidelines** may be included, consisting of Macro level transmission planning for cross border transmission network in connected countries for next 10 or 20 years, present and future import and export agreements between countries, N-1 contingency for HVDC links and N-1-1 for AC interconnections. For possible N-2 contingencies which could lead to cascade tripping, Special Protection Schemes (SPS) with adequate redundancies may be designed wherever necessary.	**Since this is the Common *Minimum* Grid Code, the Planning Code was deliberately omitted, since Grid Code are to be mandatorily complied with. Compliance of this would take very long, therefore not being possible for implementation in the near future.** **It is already mentioned in Clause 5.3 A that the new country would have to implement generation and/or load control mechanisms to be able to control cross border power flows, in case of contingencies. The new country would also have to abide by the Regional under frequency load shedding schemes to ensure commensurate load shedding in case of grid disturbances to prevent falling frequency, and also abide by the Regional islanding schemes and system protection schemes, which would be decided by the South Asian Forum of Planning bodies.** **However, if we want to prescribe a longer time frame, we can say that the Planning Code may be implemented in the next 3 years. The JWG may like to take a view.** **The JWG may like to take a view.**

SL no	POSOCO Comments	SARI/EI/IRADe Response
1.	**Comments** **Cross border Connection Guidelines** To specify the requirements to be fulfilled by the connectivity grantees prior to obtaining the permission of the system operator for first time energizing of a new or modified power system element. System Operator in consultation with planning agency shall carry out a joint system study before expected first energization of a new power system element to identify operational constraints. System Operator shall devise a First Time Charging Procedure which includes data/telemetry to be furnished by connectivity grantee and tests to be performed before applying for Trial Run	**There is already a Connection Code in the CMGC. There is also a sub-heading on the Procedure for interconnection:** ***5.2 Procedure for Inter Country connection*** *A new country seeking to establish a synchronous connection to the South Asian grid, shall submit an application, on a predetermined format, to the South Asia Forum of transmission utilities (SAFTU). After the study, the SAFTU shall lay down the minimum requirements of additional transmission infrastructure/modifications in the transmission infrastructure necessary to integrate the new country into the South Asian grid.* **What is suggested is in the nature of details of the procedure, that can come as an Annexure to the CMGC or be issued separately, on the lines of the Detailed Procedure for seeking connectivity in the CERC Regulations.**

SL no	POSOCO Comments	SARI/EI/IRADe Response
1.	**Comments** **Operational Guidelines** should cover : Outage Planning (Annually/Monthly/Weekly) Operational Security Analysis Modelling Guidelines and simulation based study (Steady State and Dynamic) Frequency band for normal operation and frequency performance quality parameters Emergency operational procedures, Voltage & reactive power management Power flow management Data Exchange (Scheduled & Real Time) Protection Code Under Frequency Load Shedding (UFLS) & Rate of Change of Frequency (df/dt) based load shedding implementation and its settings Restoration Procedures, Islanding Schemes and system security schemes	**There is already an Operating Code in the CMGC. This contains frequency control, voltage control at the interconnection point, System Security Aspects, Operation Liaison, Restoration Plans, Periodic Reports, Outage Planning.** **So, all these aspects are covered.**

SL no	POSOCO Comments	SARI/EI/IRADe Response
1.	Comments **Capacity Allocation & Congestion management guidelines for day-ahead, intra-day and long term operations** Each country must provide Available Transfer Capability (ATC) and Total Transfer Capability (TTC) for specific cross border transmission paths for long term and short term trading. Capacity calculation methodology considering reliability margin, contingency, local system changes etc. Forward capacity allocations for day ahead and intra-day operations Congestion management measures	**Agreed, we may add Congestion Management under the "Operating Code".** **However, the method of calculation of TTC, Reliability Margin (RM) and ATC and the method of Congestion Management may be given in the Detailed Procedure, which may be issued separately or attached as an Annexure to the CMGC.**

SL no	POSOCO Comments	SARI/EI/IRADe Response
1.	**Comments** **Scheduling, Dispatch and metering Guidelines** Establishment of scheduling processes Provision of information to other country system operators Outage Coordination Process Responsibility and/or applicable entities Day ahead scheduling procedure Intra-day scheduling/revision procedure Sharing of information on schedules with other trading countries Standardized Scheduling intervals for cross border transaction Metering, Accounting and Settlement Deviation Settlement Mechanism Sharing of Transmission Charges and Losses	**There is already a Scheduling and Despatch Code in the CMGC.** **All the points given here are mentioned in the CMGC. However, the method of sharing of transmission charges and losses, being a commercial mechanism, is not mentioned in the CMGC. This would have to come separately.**

Common Minimum Grid Code (CMGC): Progress

SARI/EI Drafted CMGC and shared with all Regulators & stakeholders of SA countries

Conducted Stakeholder Consultation in Bangladesh, Bhutan, Nepal

Presented CMGC in the 2nd meeting of SAFIR Working Group (Dhaka, 4th Dec,2020)

& in the 18th ECM Meeting (5th December 2019)

18th ECM recommended that each member country may form a Grid Code Review Committee consisting of all the stakeholders (utilities, system operators, planners, regulators and policy makers etc.) to discuss various features of the draft CMGC

Consultations carried out with Bhutan Grid Code Review Committee (Bhutan stakeholders) and their suggestions incorporated.

Suggestions received from POSOCO (India) and being incorporated in the draft CMGC.

Next Step

- Consultation with Bangladesh Grid Code Review Committee.
- Consultation with Nepal Grid Code Review Committee.2020
- More consultations if required.
- Submission of Revised CMGC to the SAFIR Secretariat

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IRADe Integrated Research and Action for Development

Thank You

A Roadmap for the South Asian Regional Electricity Market

Short, Medium and Long Term Steps

December 2021

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PREAMBLE

- In each SAR country, there is significant scope for power cost optimization, be it through more efficient dispatch regimes triggered by stricter regulations, or through increasing competition at the wholesale [and retail] levels. For example, preliminary studies suggest, Bangladesh can save more than $500 million annually.

- Cross-border trade can further enhance the scope of such optimization and hence benefits, e.g., Bangladesh can save well over $100 million (up to $286 million) annually from an additional GW of transfer capacity

- Markets can provide a dynamic way to capture these benefits both nationally and regionally – this presentation provides an overview of the key steps to implement a SAR wide regional electricity market (SAREM) that studies have shown can deliver more than $1 billion benefits to the region annually

CONTEXT: RATIONALE FOR SAREM

- Trade among SAR countries has nearly doubled from 9.4 TWh in 2015 to 18 TWh in 2021, albeit it remains a:
  - small fraction of long-term potential of ~400 TWh (65 GW capacity); and
  - very small fraction of overall regional power consumption of ~1400 TWh

- A South Asian Regional Electricity Market (SAREM) may facilitate flexible, transparent, efficient, two-way trade among the countries to drive necessary generation and transmission investments

- SAREM can boost liquidity in the existing Indian market (~75 TWh in FY21) and catalyze national wholesale market developments in other countries

CONTEXT: BANK'S WORK PROGRAM ON SAREM

- Cross Border Energy Trade regulation and its revisions
- Review of regulatory and institutional framework in SAR countries
- Dispatch optimization studies conducted in the past including with POSOCO and PGCB Bangladesh*
- Benefits of regional trade – short-term market-based trading (around a dispatch optimization model) and long-term planning analysis
- Analytical study to explore SAREM clearing mechanism – unified vs sequential market clearing options [see next two slides for a quick recap]

* Annex contains findings from a number of case studies for Bangladesh, India, Pakistan among other countries

SEQUENTIAL CLEARING (BENEFITS FOR INDIA-BANGLADESH TRADE FOR 2025)

	Sequential Clearing Benefits		Illustration for a slot	Scenario 1: 75% Solar and Wind Target (Annual)	Scenario 2: 100% Solar and Wind Target (Annual)
Export	Bangladesh Spot price	*[A]*	Rs 3.265/kWh	–	–
	Eastern region Spot Price	*[B]*	Rs 2.683/kWh	–	–
	North-Eastern region Spot price	*[C]*	Rs 2.683/kWh	–	–
	Export from Eastern region	*[D]*	1000 MWh	8432 GWh	8340 GWh
	Export from North-Eastern region	*[E]*	540 MWh	4553 GWh	4503.6 GWh
	Revenue from Export	***[(A – B)*D + (A – C)*E]***	**Rs 8.97 lacs**	**Rs 1741.51 Cr**	**Rs 2160.8 Cr**
Import	Bangladesh Spot price	*[A]*	Rs 3.265/kWh	–	–
	Eastern region Spot Price	*[B]*	Rs 3.749/kWh	–	–
	North-Eastern region Spot price	*[C]*	Rs 3.749/kWh	–	–
	Import to Eastern region	*[D]*	1000 MWh	328 GWh	420 GWh
	Import to North-Eastern region	*[E]*	540 MWh	177 GWh	226.8 GWh
	Savings from Import	***[(A – B)*D + (A – C)*E]***	**Rs 7.45 lacs**	**Rs 21.4 Cr**	**Rs 39.9 Cr**
Total Annual Net Benefits in 2025				**Rs 1762.9 Cr***	**Rs 2200.7 Cr***
Per Unit Impact of Cross Border Trade				***Rs 1.300 /kWh***	***Rs 1.631 /kWh***

* Rs 1762.9 crore = US$245m Rs 2200.7 crore = $305 million

UNIFIED CLEARING (BENEFITS FOR INDIA-BANGLADESH TRADE FOR 2025)

Unified Clearing Benefits			Scenario 1: 75% Solar and Wind Target	Scenario 2: 100% Solar and Wind Target
Export Quantum to Bangladesh	*From ER*	*(a)*	*8034.7 GWh*	*7951.8 GWh*
	From NER	*(b)*	*4331.8 GWh*	*4338.0 GWh*
Revenue from export to Bangladesh		*[A]*	*Rs 4813.9 crore*	*Rs 4666.9 crore*
Import Quantum from Bangladesh	*To ER*	*(c)*	*571.2 GWh*	*670.8 GWh*
	To NER	*(d)*	*342.6 GWh*	*355.5 GWh*
Cost of import from Bangladesh		*[B]*	*Rs 328.3 cr*	*Rs 386.3 crore*
Increase in thermal costs due to export - Savings in thermal costs due to import		*[C]*	*Rs 1136.9*	Rs 1614.9 GWh
Net Benefits from Unified Clearing		*[D] = [A - (B + C)]*	**Rs 3348.7 crore***	**Rs 2665.6 crore***
Per Unit Impact of Cross Border Trade		*[D / (a + b + c + d)]*	***Rs 2.531 /kWh***	***Rs 2.000 /kWh***

* Rs 3348.7 crore = US$465m Rs 2200.7 crore = $370 million

IMPLEMENTATION OF SAREM: OVERVIEW

Objective: Bilateral trades (current state) → Multi-lateral trade → Wholesale spot market- based trading of energy and ancillary services by all countries

Orderly process needed to:

- Short term: Ensure generators/traders from a country can participate in the incumbent Indian power exchanges
- Medium term: Maximize the potential gains of trade including dispatch optimization and development of national markets in each country
- Long term: Trade among multiple markets – unified SAREM

Our current focus is primarily on the short and medium-term issues

IMPLEMENTATION OF SAREM: SHORT-TERM (~1 YEAR)

- Pre-conditions for participants to join existing market in India that are already met: Revised CBET regulation and Designated Authority clearance by CEA
  - Continuation of existing CBET as per contractual arrangements is possible
  - Participation in the Indian power exchanges

- Pre-conditions for countries to develop their own markets that are partially met: (a) Access and transmission pricing arrangements (b) unbundling of generation-transmission-distribution or at least separation of functions/accounts (c) minimum number of players to induce competition
  - Potentially different pace of wholesale market development

- Pre-conditions that are yet to be met: (a) Energy accounting and settlement system including separate accounting for injection and drawl (b) Scheduling and deviation settlement mechanism (c) incorporating CBET in daily dispatch and planning in a phased manner (e.g., move contracted volume to spot over the years and design future contracts allowing for more market exposure)

IMPLEMENTATION OF SAREM: MEDIUM-TERM (2-4 YEARS)

National market:

- Implementation of day-ahead and real-time dispatch optimization to realize the dispatch efficiency and CBET benefits
- Participation of domestic market participants in Indian power exchange real-time market (RTM) [e.g., Western Energy Imbalance Market (EIM, California) style mechanism]
- Create market institutions (independent system/market operator) and strengthen regulatory capacity to support market development
- Develop a national market design, associated market rules, transition mechanism, market clearing mechanism, products (energy as well as ancillary services)

Regional market:

- Decision on sequential vs unified regional market design or a mix of the two (start with sequential and form a unified regional market in the long term?)
- Develop a CBET transmission regulatory mechanism [e.g., ENTSOE Ten Year Network Development Plan and cost benefit test]
- Integrate CBET in the regional as well as national market

IMPLEMENTATION OF SAREM: LONG-TERM (4+ YEARS)

- Consolidate and grow a regional electricity market – enhance liquidity, introduce/sharpen financial instruments to manage participant risks
- Develop ancillary services markets and trading of ancillary services products through multi-country/regional control area
- Formation of regional apex bodies for coordination and planning

PRELIMINARY RECOMMENDATIONS TO IDENTIFY GAPS AND SET PRIORITIES*

1. Re-assess benefits on an ongoing (daily) basis of a greater degree of participation of Nepal, Bhutan and Bangladesh CBET through Indian PX over the next year including two-way trades –

   - Initiate a pilot for each of the incumbent links and assess daily trading benefits
   - Consider introducing flexibility in the current contracts if benefits are significantly higher than the current contractual terms allow for
   - Form a basis for market exposure of new contracts

2. Fast track measures like scheduling, metering, accounting and settlement systems (including Deviation Settlements Mechanism) that are absolutely critical for all countries

* These will need to vetted and examined more closely through discussions and studies

PRELIMINARY RECOMMENDATIONS TO IDENTIFY GAPS AND SET PRIORITIES*

3. Dispatch optimization: Introduce
   - At minimum - a day ahead dispatch optimization mechanism in all countries
   - Real-time optimization connected to the SCADA system
   - Optimization of CBET in tandem with domestic generation

4. Form a clear view on where domestic markets are implementable in the short-term (i.e., the preconditions can realistically be met in 1-2 years) and if a market can commence in the medium term:
   - Undertake a stakeholder consultation
   - Develop a roadmap for market development
   - White paper on design of the market

* These will need to vetted and examined more closely through discussions and studies

PRELIMINARY RECOMMENDATIONS TO IDENTIFY GAPS AND SET PRIORITIES*

5. There are issues for which studies and explorations are needed in the long term but requires actions in the short-term including:

   - Development of transition mechanisms that will eventually be needed for countries that are ready for development of national markets, but generation sector is dominated by PPAs
   - Introduction of economic regulation of transmission
   - Explore the structure of a regional transmission body

* These will need to vetted and examined more closely through discussions and studies

Proposed Immediate Next Step

- Feedback on the proposed short, medium and long term action steps, discussion with the power secretaries including views on tentative timeline for each step (in the next 2-3 weeks)

- Develop a TOR for developing a road map (within 6 weeks – say mid Jan 2022)

- Engage a consulting firm to develop the steps in detail (TBD following Power Secretaries Roundtable)

THANK YOU

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ANNEX: DISPATCH EFFICIENCY STUDIES

Rationale and Case Studies

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INTRODUCTION

What is it?

- It is a check on the dispatch process – system being **operated** in a least-cost manner?
- Compares actual dispatch with a simulated counterfactual/optimal dispatch
- Any difference may reveal some deficiency/constraint in the system

Why do it?

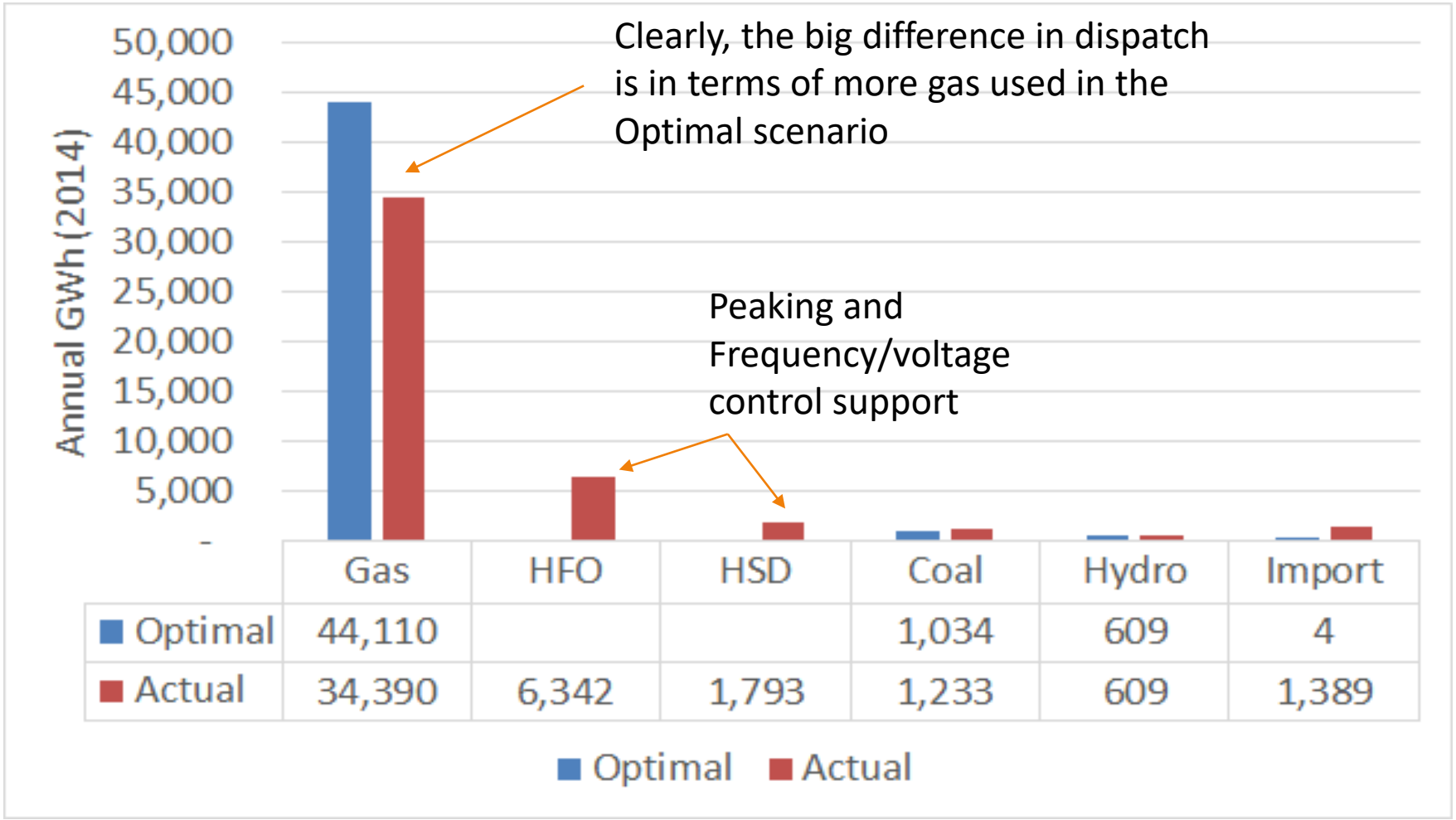
1. Potential savings can be significant that can often be achieved with very little investment, e.g., use an optimization-based tool
2. Identify critical investment opportunities, e.g., transmission upgrade, frequency control, voltage control, fuel supply bottlenecks
3. Important policy interventions on take-or-pay obligations, gas allocation, RE target
4. Important part of introducing the basic discipline in control centers to integrate solar and wind, but also to realize that usual/old dispatch habits are sub-optimal

CASE STUDIES

Country	Issue	Resolution & savings	Outcome
Bangladesh (2015/16)*	Almost 20% liquid fuel based generation in 2014. Blamed on lack of gas	Available gas could be used more efficiently. Liquid fuel was being burnt unnecessarily for frequency support. Potential savings > $1 billion per year even without increasing gas allocation! Some transmission congestion issues.	We worked with PGCB/NLDC to initiate frequency control trials. Reduced oil support. Initiated a dispatch efficiency investment project to upgrade transmission

** Shows when the study was done*

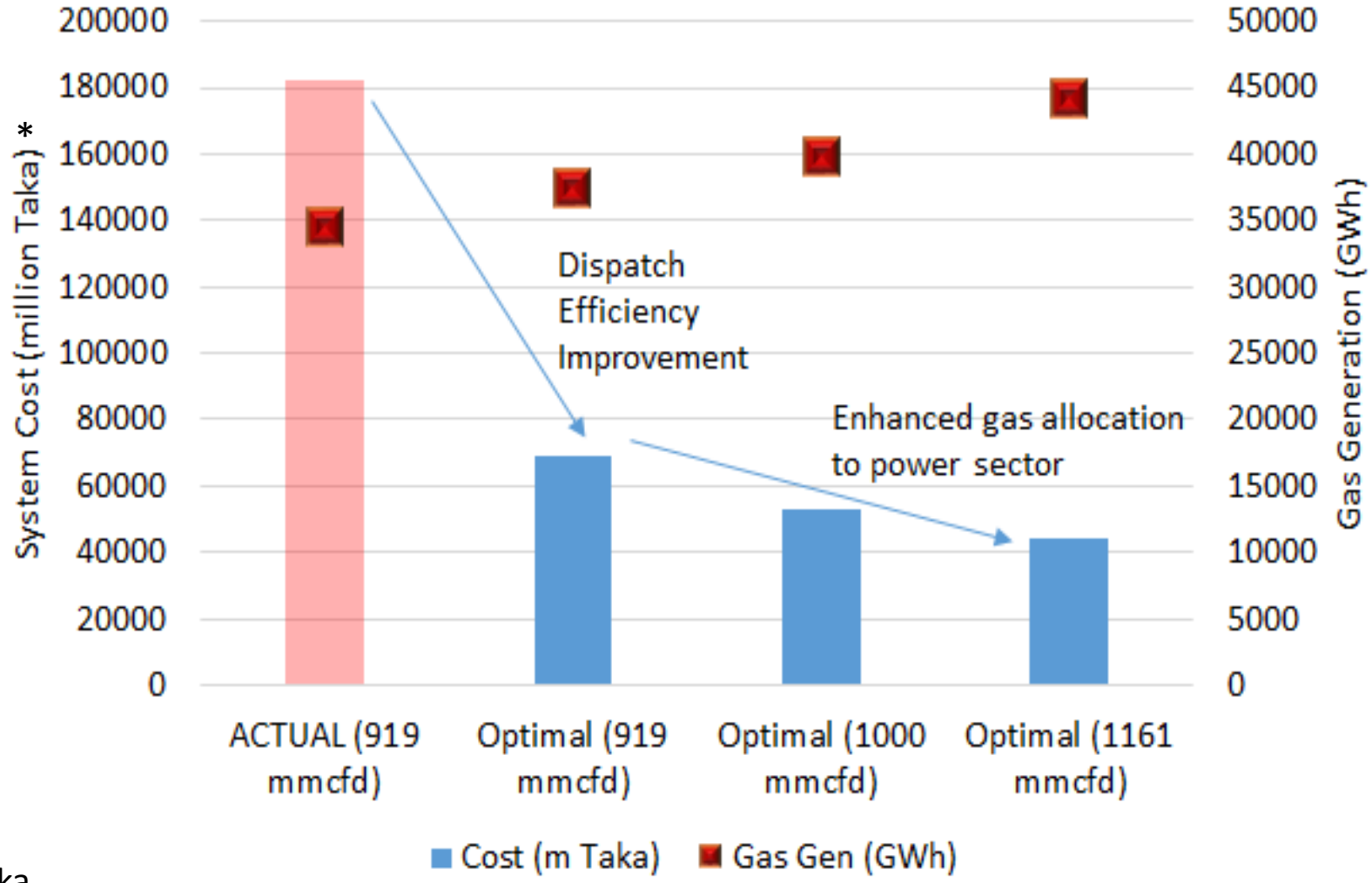
BANGLADESH: COMPARISON OF ACTUAL VS OPTIMAL DISPATCH



	Gas	HFO	HSD	Coal	Hydro	Import
Optimal	44,110			1,034	609	4
Actual	34,390	6,342	1,793	1,233	609	1,389

BANGLADESH: COMPARISON OF ACTUAL VS OPTIMAL DISPATCH

Available gas could be used to generate more in efficient generating units and massively reduce cost by $1.4b. Additional gas would of course help to generate more from these plants



* 1 USD = 80 Taka

CASE STUDIES

Country	Issue	Resolution & savings	Outcome
India (2017-current)	Lack of cost discipline by POSOCO to schedule central sector plants (mostly coal). Blamed on protocols such as fixed allocation of central sector plants to states, how transmission rights are allocated, etc	Possible to generate decent amount of savings without breaching any of the protocols on allocation to states. Savings > $100 million per year and over $400 million over the last 3+ years through relatively small adjustments among coal plants	POSOCO implemented a real-time version of dispatch engine (SCED) running live for > 3 years now (https://posoco.in/#)

** Shows when the study was done*

INDIA: KEY RESULTS*

Security Constrained Economic Dispatch (15-minute real-time operation through SCADA) for Apr-Dec 2019

Parameter	Value	Comments
Participant	52 central sector plants, 58 GW (coal+lignite)	Ambit of SCED will be expanded to include central sector hydro and ancillary services
Benefit: Reduction in cost ($m)	$121 million over 9 months (Rs 8.45 billion) – 1.5% of overall costs	Real savings distributed back to the generators
Benefit: Reduction in number of changes in dispatch instructions and volume (MW)	29% reduction in number of dispatch instructions and 42% reduction in volume (MW)	Results in a much smoother operation of coal plants. Efficient plants stay on all the time at max level and inefficient ones are shut down or remain stable at min loading

* POSOCO SCED Detailed Feedback Report. SCED received good press coverage e.g., here and here

Additional Case studies

Country	Issue	Resolution & savings	Outcome
Uzbekistan (2018/19)	High utilization of inefficient plants. Blamed on inflexible units and gas constraints.	Potential to save USD 34 million through a change in the dispatch of plants only (with gas and transmission constraints).Benefits close to $100m if gas and tx constraints are removed. Demonstrated limited impact of near-term VRE capacity (600MW).	Worked with the NLDC to pilot the tool to enhance scheduling of plants. Government's ambitious RE program has taken off with 100MW WBG solar PV plant and the NLDC better equipped to analyze VRE.
Myanmar (2018)	20%-25% of available hydro energy (~2500 GWh) is being spilled. Blamed on north-south tx constraints	Bulk of the water spilled could actually be used to save $220m pa thermal costs. Take or pay obligations of thermal is the bigger issue that reduces benefits to $140m. Transmission upgrade necessary for new hydro projects.	Limited impact so far as most projects are on hold. There is much better awareness on the issue. Dispatch and planning analysis helped to reduce emergency rentals.

CASE STUDIES

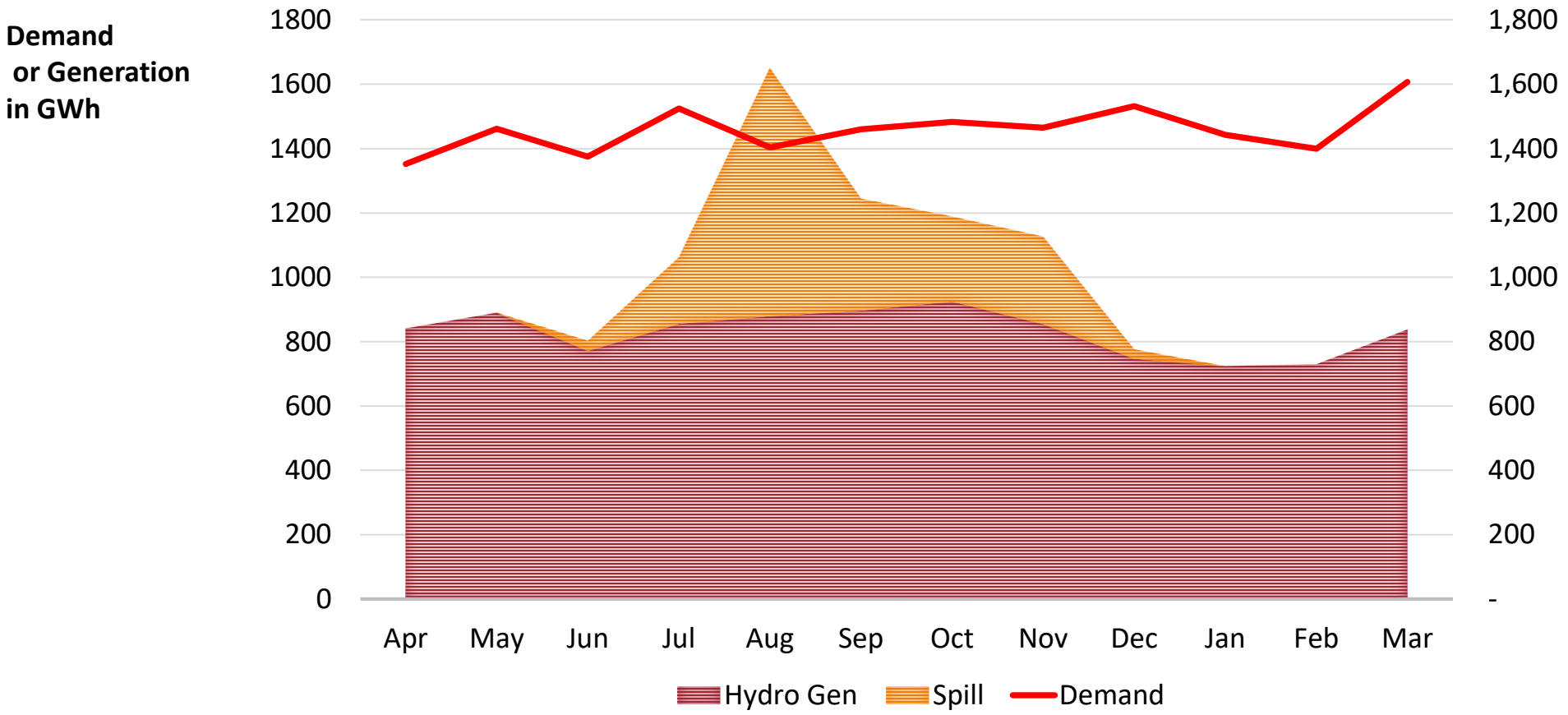
Country	Issue	Resolution & savings	Outcome
Pakistan (2019/20)	Around 8% (~10,000 GWh) of liquid fuel generation (in 2018/19). Unclear why these plants are still being used because there is cheaper thermal available	Potential savings close to $1b even if all the commercial PPAs are honored. 80%-90% of liquid fuel generation can be avoided. Coal generation picks up.	Ongoing study. Initial discussions with NPCC is encouraging
Nigeria (2019/20)	13 GW installed capacity struggles to meet 5 GW peak (2018). Plant availability, gas supply, transmission and distribution constraints all contribute to this problem – relative contribution of these factors is unclear	Initial analysis suggests pure dispatch efficiency can contribute $30m (4%) savings, making more gas available would increase this to $118m (15%). The system with more gas can meet 16% additional demand.	Ongoing study. Yet to discuss with TCN.
Kenya (2020)	Small but significant diesel generation retained in the mix. Blamed on voltage support	Hydro and geothermal dispatch can be vastly improved to save $104m in 2019 (35%!).	Ongoing study. Findings presented to KPLC

UZBEKISTAN: KEY RESULTS

	Actual A	Unconstrained B	Difference C=B-A	Gas and Transmission constraints D	Difference E=D-A
Thermal Cost:Bill UZS	7,247.3	6,419.9	-827.4	6,961.9	-285.4
Hydro Gen:GWh	7,622.0	7,358.7	-263.3	7,358.7	-263.3
Gas Gen:GWh	34,404.0	43,110.3	8,706.3	43,038.4	8,634.4
Coal Gen:GWh	14,398.0	9,586.9	-4,811.1	9,586.9	-4,811.1
Oil Gen:GWh	630.0	0.0	-630.0	0.0	-630.0

- **Potential** savings of UZS 285 billion through improved utilization of plants (equivalent to USD 34 million) with constraints.
- Savings are even higher without constraints. Gas and transmission constraints cost result in additional costs of UZS 542 billion (USD 64 million)

MYANMAR: MASSIVE HYDRO SPILL BULK OF WHICH *CAN BE* USED TO DISPLACE THERMAL



Note: During August hydro availability (including spillage) exceeds demand – absent sufficient storage that exceeds beyond a month, hydro spill would be unavoidable. Spill calculated conservatively using 0.2 MWh/acre-foot

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MYANMAR: ACTUAL VS OPTIMAL (FY 2017)

Optimal scenario assumes minimum PPA generation obligations but do not enforce plant specific gas limits

		Actual	Optimal	Diff*
Hydro	GWh	8,984	11,501	2,517
Thermal	GWh	7989	6,261	-1,728
Thermal Cost	Bill MMK	1175	881	-293

***Actual**: Actual operation in FY 2016/17.*
***Optimal**: Optimized dispatch to strictly follow merit order dispatch for all hours*

- Hydro is underutilized by 2,564 GWh including spill (a part of which is unavoidable).
- **Thermal/gas cost reduces by 293 billion MMK (USD 220 million)**
- There are other economic benefits (reduction in load shed which we don't consider). *[Note that there is 789 GWh of additional demand met in Optimal]

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PAKISTAN: ACTUAL VS OPTIMAL (FY 2018/19)*

Category	Variable Generation Costs [million $]			
	ACTUAL	OPTIMAL	DIFFERENCE	
OCGTs	9	14	5	57%
STs	616	112	-504	-82%
Combust. Eng.	537	46	-491	-91%
CCGTs	3,466	3,436	-30	-1%
Nuclear	74	74	0	0.2%
Coal PPs	870	968	98	11.3%
TOTAL	5,572	4,651	-921	-16.5%

- **Relatively small generation from steam turbines (ST) and combustion engines translate into very high cost that is entirely avoidable and can save $1 billion**
- **Coal generation will go up to replenish for it.**
- **Overall savings is $921 million**

** Tractebel study draft report dated May 24, 2020*

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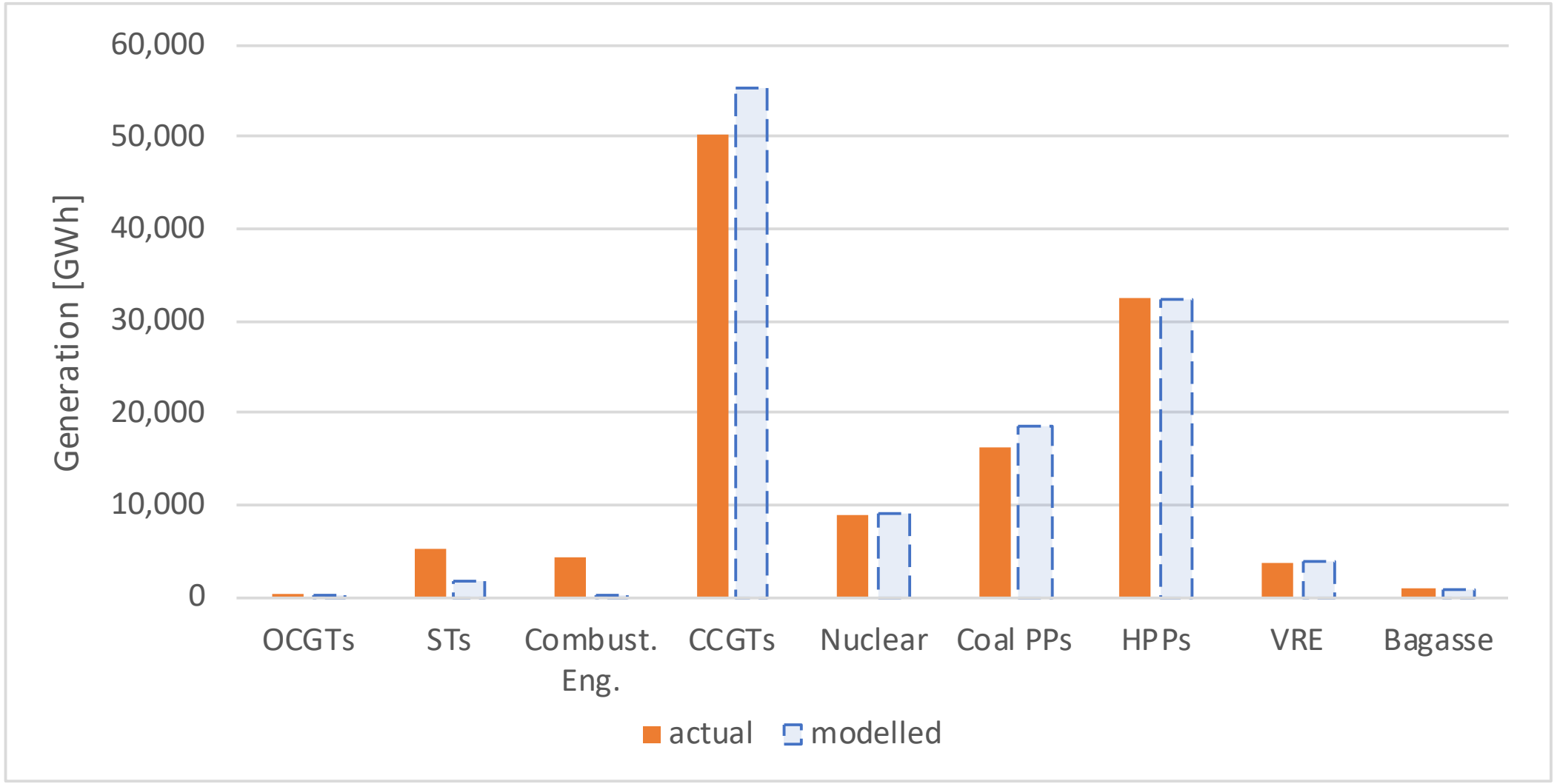
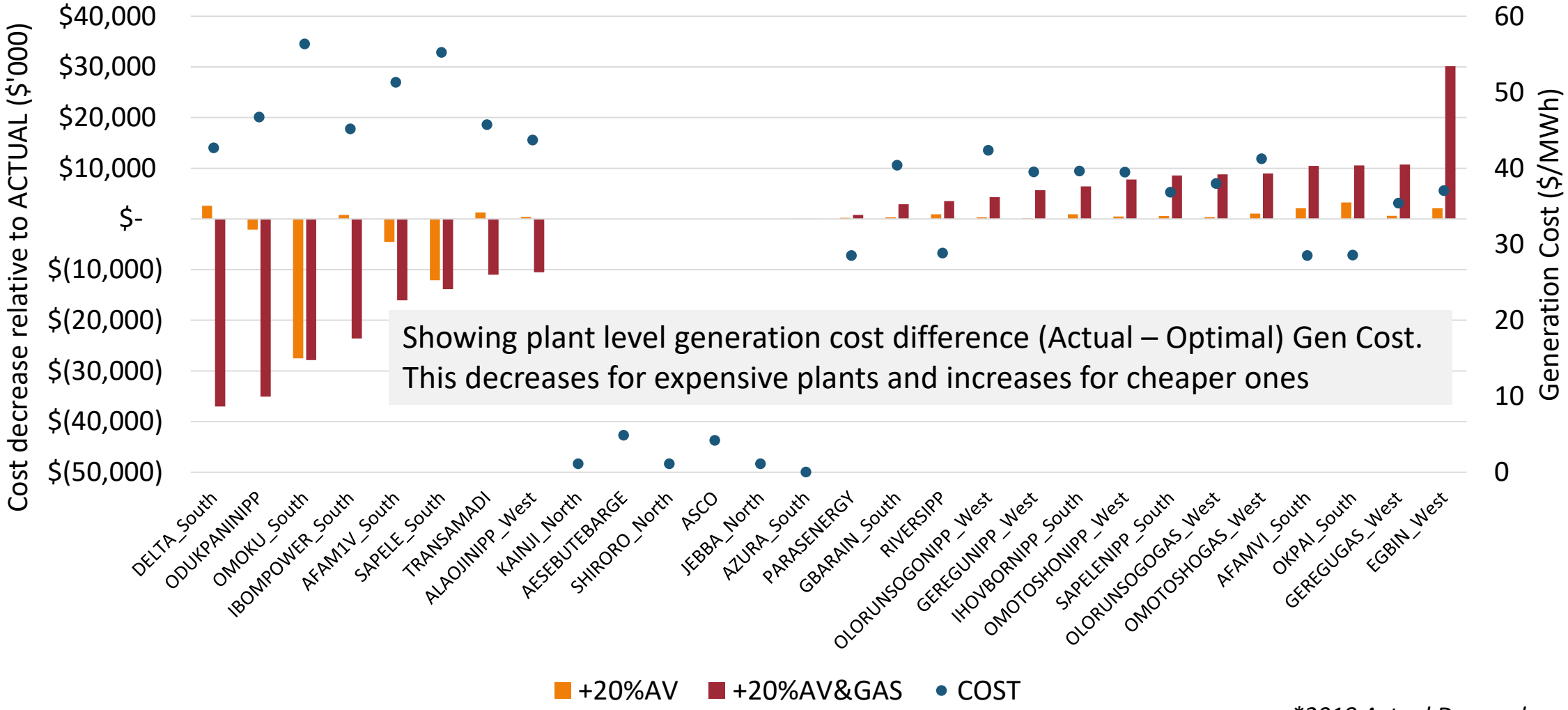
PAKISTAN: MODEL VALIDATION (ACTUAL VS MODELLED/OPTIMAL)

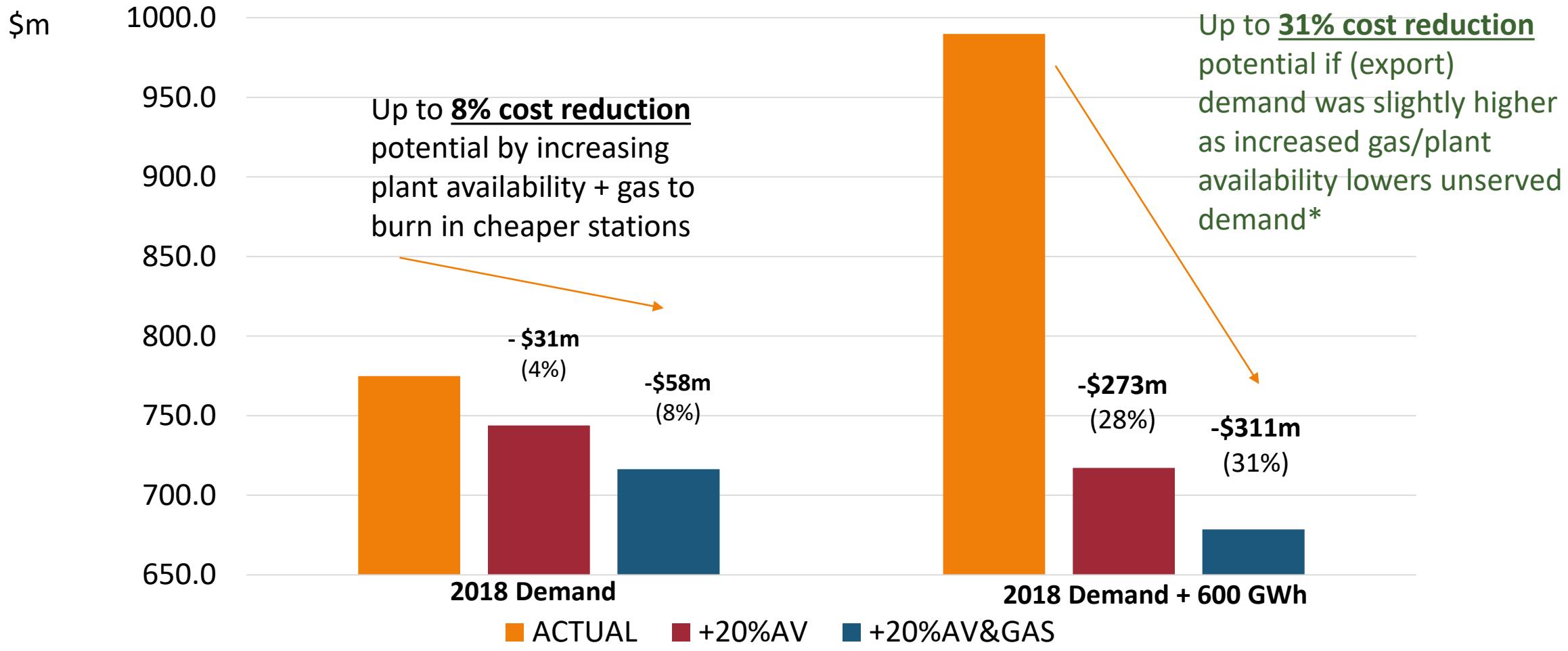


NIGERIA: CHANGE IN GENERATION COST RELATIVE TO ACTUAL*



*2018 Actual Demand

NIGERIA: OBJECTIVE FUNCTION (FUEL + O&M COST + UNSERVED DEMAND COST*– EXPORT REVENUE)



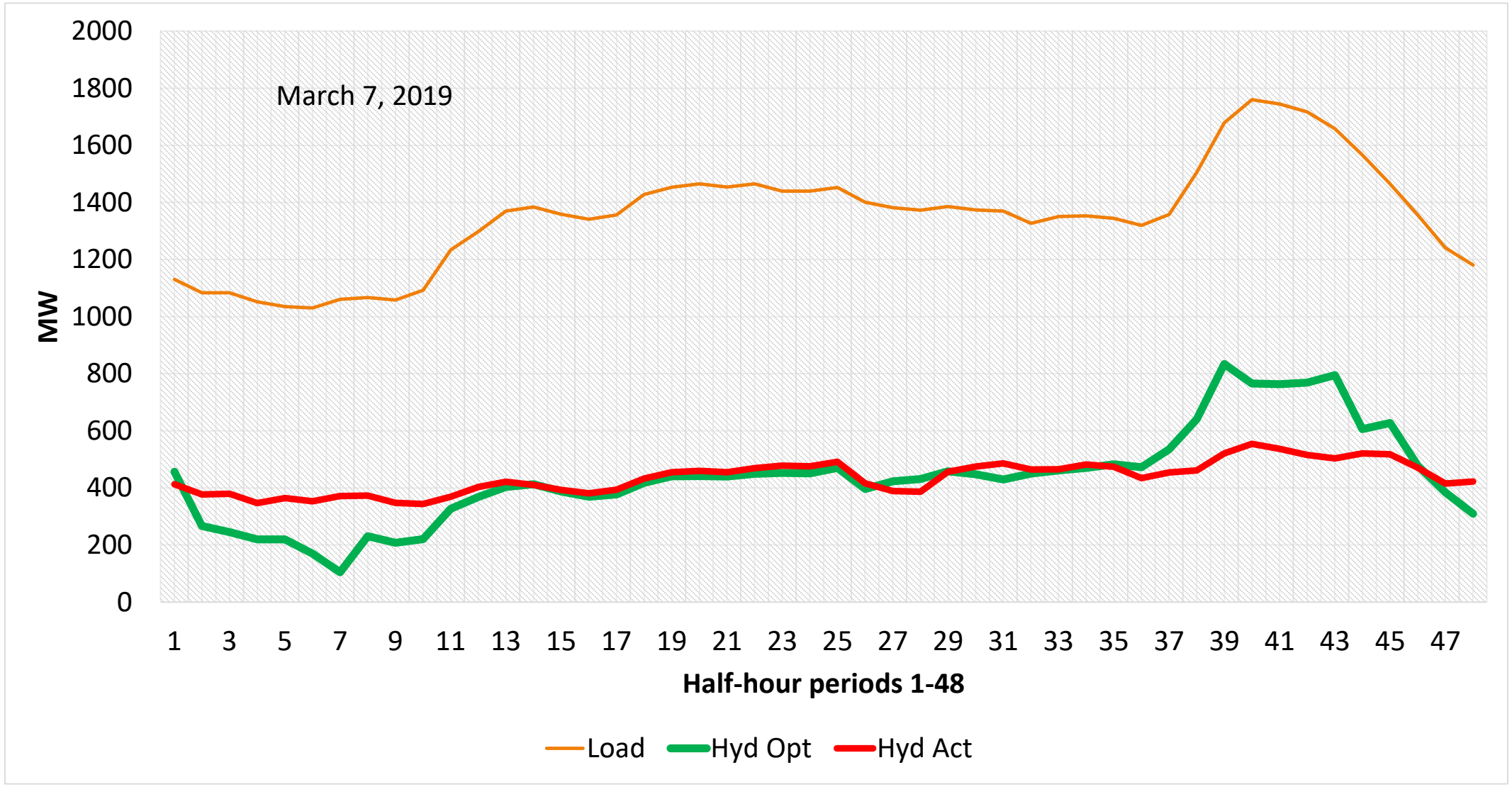
* Valued at 50c/kWh

KENYA: ACTUAL VS OPTIMAL (2019)

	Optimal GWh	Optimal Cost $m	Actual GWh	Actual Cost $m
Hydro	3,111	2	3,135	4
Geothermal	5,824	137	4,725	114
Diesel	100	9	1,149	130
GT			26	5
Wind	1,525	24	1,525	24
Biomass	0	0	0	0
Solar	90	1	90	1
Import	205	10	205	10
Export	16	1	16	1
TOTAL	10,871	185	10,871	289
Benefit of Optimized Dispatch = 289-185 = $104 million for 2019				

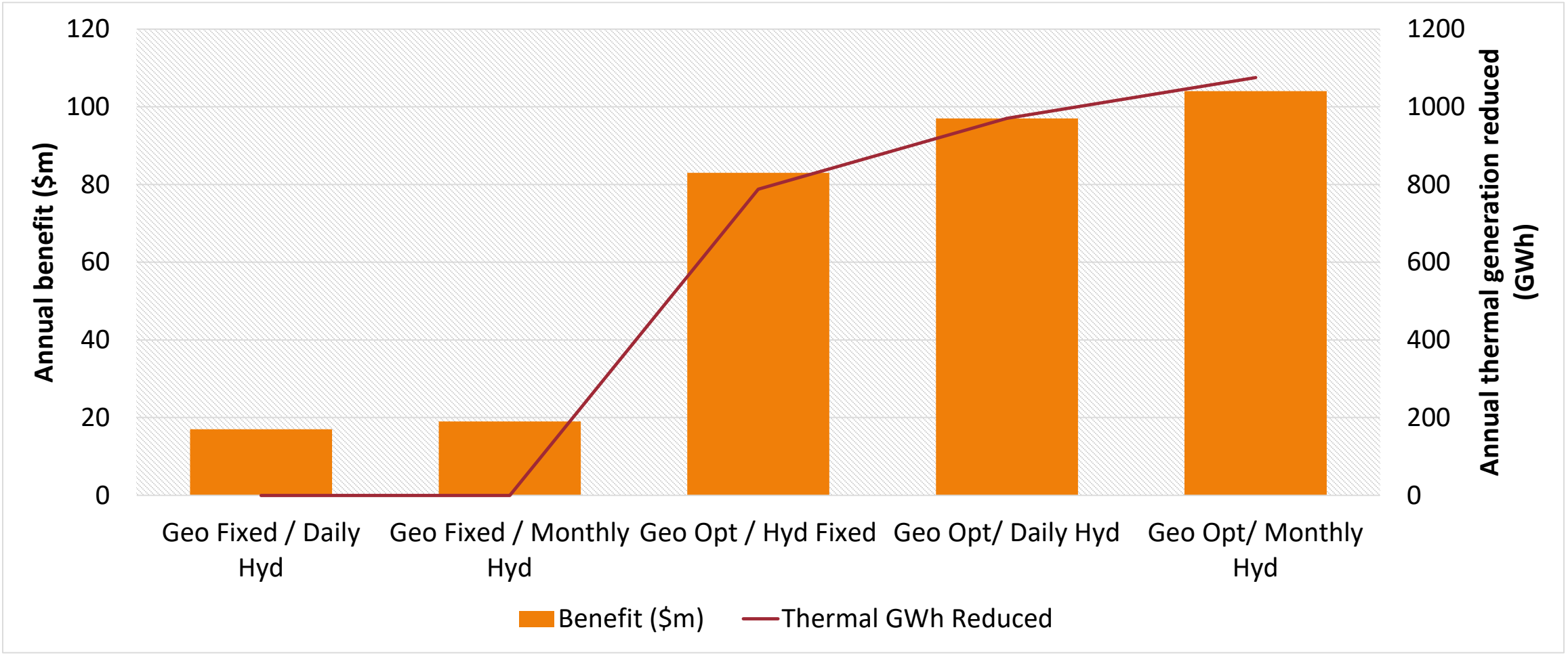
- **Significant room to utilize geothermal better provided hydro dispatch is optimized to preserve water during day and used for peaking in the evening**
- **Overall savings is $104 million or 35% of actual cost**

KENYA: SAMPLE OF HYDRO DISPATCH COMPARISON



KENYA: BENEFITS FROM INCREMENTAL IMPROVEMENTS

Benefits can be built gradually through incremental improvements e.g., adjust hydro within a day only to get just under $20m but bigger benefits come when geothermal generation is utilized more optimally to reduce thermal



Concluding Remarks

- Dispatch modeling can be a relatively low-cost and quick way to diagnose a range of deficiencies in the system from lack of dispatch discipline to inefficiency of PPAs and transmission and fuel related physical constraints

- It can also be an excellent framework to test and prioritize options to improve dispatch efficiency, e.g., critical PPAs or transmission lines or fuel constraint to mitigate and possibly a lot more like demand side options including energy efficiency and demand response measures

- Such an analysis also provides the foundation for wholesale markets – the marginal costs calculated from a dispatch model are essentially predecessors of spot prices