PCA Case No. 2023-01

IN THE MATTER OF AN ARBITRATION

-before-

THE COURT OF ARBITRATION CONSTITUTED IN ACCORDANCE WITH THE INDUS WATERS TREATY 1960

-between-

THE ISLAMIC REPUBLIC OF PAKISTAN

-and-

THE REPUBLIC OF INDIA

CERTIFIED TRANSCRIPT (SITE VISIT)

COURT OF ARBITRATION:

Professor Sean D. Murphy (Chairman) Professor Wouter Buytaert Mr. Jeffrey P. Minear Judge Awn Shawkat Al-Khasawneh Dr. Donald Blackmore

SECRETARIAT:

The Permanent Court of Arbitration

ON BEHALF OF THE COURT OF ARBITRATION:

Sean D. Marphy

Professor Sean D. Murphy Chairman

CERTIFIED PURSUANT TO PARAGRAPH 19 OF ANNEXURE G

24 April 2024

Arbitration pursuant to Article IX and Annexure G of the Indus Waters Treaty 1960

Pearl Continental Hotel Muzaffarabad Pakistan-administered Kashmir and Jammu Region

Day 2 Site Visit to the NJHEP Wednesday, 24th April 2024

Before: PROFESSOR SEAN D MURPHY PROFESSOR WOUTER BUYTAERT MR JEFFREY P MINEAR DR DON BLACKMORE

MR STEPHEN POMPER, NEUTRAL OBSERVER

BETWEEN:

THE ISLAMIC REPUBLIC OF PAKISTAN

-and-

THE REPUBLIC OF INDIA

Transcript produced by Lisa Gulland and Trevor McGowan

APPEARANCES

FOR THE ISLAMIC REPUBLIC OF PAKISTAN

MR RAJA NAEEM AKBAR, Ministry of Law and Justice MR SYED ALI MURTAZA, Ministry of Water Resources MR SYED MUHAMMAD MEHAR ALI SHAH, Commissioner for Indus Waters Mr ILYAS MEHMOOD NIZAMI, Ministry of Foreign Affairs MR SOMEIR SIRAJ, Office of the Attorney General for Pakistan MS ZAINAB MALIK, Office of the Secretary of Law and Justice SIR DANIEL BETHLEHEM KC, Twenty Essex, London PROFESSOR PHILIPPA WEBB, Twenty Essex, London DR CAMERON MILES, 3 Verulam Buildings, London DR GREGORY L MORRIS, Technical Advisor MR PETER J RAE, Technical Advisor

THE REPUBLIC OF INDIA WAS NOT REPRESENTED

SITE EXPERTS

MR MUHAMMAD AZAM JOYA, Pakistan Water and Power Development Authority (WAPDA) MR USMAN-E-GHANI, Additional Commissioner for Indus Waters DR TAHIR MAHMOOD HAYAT, Diamer Basha Consultants Group MR MUHAMMAD ARFAN MIANA, Neelum Jhelum Hydropower Company (NJHPC) MR MUHAMMAD AYUB MALIK, NJHPC MR NAYYAR ALAUDDIN, NJHPC MR MUHAMMAD UMAR FAROOQ, National Engineering Services Pakistan (NESPAK) MR FIAZ HANIF SENDHU, Tarbela 5th Extension Project MR ARSHAD MALIK, WAPDA DR YASIR ABBAS, NESPAK MR MUHAMMAD TARIQ, Tarbela 4th Extension Project MR HAMEEDULLAH KHAN, Warsak Hydro-Electric Project FOR THE PERMANENT COURT OF ARBITRATION MR GARTH SCHOFIELD, Deputy Secretary General MR BRYCE WILLIAMS, Legal Counsel MR SEBASTIAN KING, Assistant Legal Counsel

MR DAAN NIEUWLAND, Videographer

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Court questions

1	Wednesday, 24 April 2024	1	We understand that our task is to assist you in
2	MR JOYA: Good afternoon, everyone, Chairman Murphy and	2	getting a better feel for the reality of HEP design,
3	members of Court of Arbitration. My name is Muhammad	3	operation, by seeing a run-of-river plant in the flesh,
4	Azam Joya, and I am General Manager of Pakistan Water	4	through the lens of one such Pakistan plant, the NJHEP.
5	and Power Development Authority, known as WAPDA.	5	Having said this, you should please feel free to ask
6	In that capacity, it's my pleasure to welcome you	6	us questions as we go along. I cannot promise that we
7	and the wider delegation from the Permanent Court of	7	will be able to answer everything that you may ask. And
8	Arbitration to Muzaffarabad for what will hopefully be	8	we say so: if we cannot, please don't hesitate to ask.
9	an informative site visit of WAPDA's Neelum Jhelum	9	WAPDA has accepted this mission with utmost
10	hydropower plant known as NJHEP afterwards.	10	seriousness, and has assembled from around Pakistan
10	I'm speaking in the place of Lieutenant General	10	an array of leading experts in geology, hydrology,
12	Sajjad Ghani, Chairman of WAPDA, who unfortunately was	11	geography, design and power systems, as well as various
12	unable to be with us today due to some urgent and	12	branches of engineering, to discharge it.
13 14	unavoidable business.	15	
		14	Slide 3. It remains only for me to introduce you to
15	Assisting me in this introductory presentation is		the NJHEP itself. It is one of WAPDA's proudest
16	Mr Usman-e-Ghani, Additional Pakistan Commissioner for	16	achievements: a 969 MW run-of-river HEP, sitting
17	the Indus Waters. I think he is here on the second	17	44 kilometres outside of Muzaffarabad, where we are
18	seat.	18	right now. The NJHEP was designed and built between
19	By way of background, WAPDA is one of Pakistan's	19	2008 and 2018. It now contributes 5,150 GWh of clean
20	largest and oldest government agencies, created by	20	and reliable energy to the national grid every year. So
21	Pakistan Water and Power Development Authority Act 1958,	21	it is a test bed for many similar HEPs that WAPDA wishes
22	it's headquartered at Lahore. It's a public utility in	22	to develop in this region.
23	charge of developing, maintaining and managing	23	Over the course of the next few days, you will
24	publicly-owned hydropower facilities in Pakistan.	24	become very familiar with the NJHEP and, through it, the
25	At the present point in time, WAPDA controls some 23	25	process by which a run-of-river hydroelectric plant is
	Page 1		Page 3
1	hydroelectric plants, or HEPs, with a total installed	1	built and operated in these Himalayas rivers. The
1 2	hydroelectric plants, or HEPs, with a total installed capacity of 9,476 MW. By 2028, we hope to add a further	1 2	built and operated in these Himalayas rivers. The entire facility is at your disposal and, should you wish
1 2 3	capacity of 9,476 MW. By 2028, we hope to add a further		
2	•	2	entire facility is at your disposal and, should you wish
2 3	capacity of 9,476 MW. By 2028, we hope to add a further 9,000 MW of hydropower to the national grid through	2 3	entire facility is at your disposal and, should you wish to inspect any element of it, you have only to ask for
2 3 4	capacity of 9,476 MW. By 2028, we hope to add a further 9,000 MW of hydropower to the national grid through megaprojects like Tarbela 5th Extension, Diamer Basha	2 3 4	entire facility is at your disposal and, should you wish to inspect any element of it, you have only to ask for it, sir.
2 3 4 5	capacity of 9,476 MW. By 2028, we hope to add a further 9,000 MW of hydropower to the national grid through megaprojects like Tarbela 5th Extension, Diamer Basha dam, Monmouth Hydroelectric Power Projects, and	2 3 4 5	entire facility is at your disposal and, should you wish to inspect any element of it, you have only to ask for it, sir. Thank you very much. I now turn the floor over to
2 3 4 5 6	capacity of 9,476 MW. By 2028, we hope to add a further 9,000 MW of hydropower to the national grid through megaprojects like Tarbela 5th Extension, Diamer Basha dam, Monmouth Hydroelectric Power Projects, and elsewhere as well.	2 3 4 5 6	entire facility is at your disposal and, should you wish to inspect any element of it, you have only to ask for it, sir. Thank you very much. I now turn the floor over to Chairman Murphy for any remarks you wish to make, sir.
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$\begin{array}{c} 2 \\ 3 \\ 4 \\ 5 \\ 6 \\ 7 \\ 8 \\ 9 \\ 10 \\ 11 \\ 12 \\ 13 \\ 14 \\ 15 \\ 16 \\ 17 \\ 18 \\ 19 \\ 20 \\ 21 \\ 22 \\ 23 \\ 24 \end{array}$	capacity of 9,476 MW. By 2028, we hope to add a further 9,000 MW of hydropower to the national grid through megaprojects like Tarbela 5th Extension, Diamer Basha dam, Monmouth Hydroelectric Power Projects, and elsewhere as well. It is an exciting time for us, and we hope that you will feel some of the excitement in the course of your visit. Slide 2. The parameters of site visit as directed in your Procedural Order No. 10 are reflected, for the record, on the slides. It has been important for all of the site experts who will be making presentations to you to understand these parameters. Sir, we all are engineers, not lawyers. And perhaps, with some exceptions here and there, we have no knowledge or familiarity with the details of the dispute between Pakistan and India that has brought you here for the site visit. Nor are we knowledgeable about the Indus Waters Treaty. Rather than discuss these matters, and mindful of the directions given in your Procedural Order No. 10, we have come here to prepare to talk to you about the design, construction and operation of HEPs in our part of the world in a relative ignorance of how	2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24	 entire facility is at your disposal and, should you wish to inspect any element of it, you have only to ask for it, sir. Thank you very much. I now turn the floor over to Chairman Murphy for any remarks you wish to make, sir. THE CHAIRMAN: Thank you very much, Mr Joya, for those welcoming remarks. I will say a few words on behalf of the Court of Arbitration. But before I do that, perhaps I will allow the members of the Court of Arbitration to introduce themselves. My name is Sean Murphy. I am the Chairman of this Court of Arbitration. I'm also a Professor of International Law at George Washington University in Washington DC. So to the extent that my questions are very simplistic, coming from a non-engineer, you'll understand why that's the case. Mr Minear, would you like to introduce yourself? MR MINEAR: Thank you, Sean. My name is Jeffrey Minear. I'm from the United States, and my training is as a lawyer. I'm here as a legal umpire on the Court of Arbitration. I also have training in natural resource management and as a chemical engineer, and I'd like to thank you at the outset for taking the time to share

		1	
1	forward to learning a good deal today and in the days	1	All the movies the could of the table 's March at
1	forward to learning a good deal today and in the days	1	All the way at the end of the table is Mr Garth
2	ahead.	2	Schofield. He is the court's registrar, and he is also
3	THE CHAIRMAN: Mr Blackmore.	3	the Deputy Secretary General of the PCA.
4	DR BLACKMORE: Thank you. My name is Don Blackmore. I'm	4	Mr Bryce Williams is over there, just raised his
5	a civil engineer. I used to run a water business in	5	hand. He is the court's treasurer, also a member of the
6	Australia that covers an area just a bit bigger than	6	staff of the Permanent Court of Arbitration, and is
7	Pakistan, about 1 million square kilometres, and have	7	assisting generally in the arbitration.
8	owned and managed a number of hydroelectric plants in	8	And then Mr Sebastian King, here on my right, from
9	the past. I was a commissioner on the World Commission	9	the PCA staff.
10	on Dams that looked at the development and effectiveness	10	So those are the individuals who are helping
11	of the 50,000 large dams on earth, so I've seen dams in	11	administer the arbitration.
12	every setting, in every continent, bar Antarctica: they	12	We also have, as a part of the court's delegation, a
13	didn't invite me to Antarctica. So I bring an interest	13	videographer, who is standing behind the camera there,
14	in what you've done with this dam, and I will listen	14	Mr Daan Nieuwland. He will be taking the video
15	with great interest, so thank you.	15	throughout the course of the visit.
16	THE CHAIRMAN: Professor Buytaert.	16	And then we have a person who is serving as the
17	PROFESSOR BUYTAERT: Thank you very much. Good afternoon,	17	Neutral Observer. That's Mr Stephen Pomper, towards the
18	everyone. My name is Wouter Buytaert. I'm a Professor	18	end of the table there. He is an individual who works
19	in Hydrology and Water Resources at Imperial College	19	at the International Crisis Group, although he is acting
20	London.	20	here in his personal capacity. And I'll say a little
21	In case you wondered about my accent, I'm originally	21	more about the Neutral Observer in just a minute.
22	from Belgium, but I've been based in London for now 15	22	So let me, first of all, thank the Government of
23	years. I'm an environmental engineer by training, and	23	Pakistan for organising this site visit. The Court of
24	have worked several decades already on mountain	24	Arbitration is extremely grateful to you and to all of
25	hydrology in particular, but all over the world: a long	25	the site visit experts, who we know have already put in
	Dage 5		Dage 7
	Page 5		Page 7
1	history in South America, but to a lesser extent also	1	a lot of work in preparing yourselves for the next
2	here in this part of the world. So I'm particularly	2	few days. That's evident from the various slides that
	here in this part of the world. So I'm particularly interested in the broader hydrological/geomorphological		few days. That's evident from the various slides that you've prepared and shared with us in advance, and I'm
2	here in this part of the world. So I'm particularly interested in the broader hydrological/geomorphological setting of the dam, and the way that the engineering	2 3 4	few days. That's evident from the various slides that
2 3	here in this part of the world. So I'm particularly interested in the broader hydrological/geomorphological setting of the dam, and the way that the engineering design has adapted to these settings.	2 3	few days. That's evident from the various slides that you've prepared and shared with us in advance, and I'm
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1	We have several external counsel, led by Sir Daniel	1	receive arguments on the application of facts to the
2	Bethlehem here. We are very grateful for all of the	2	law, including with respect to the interpretation or
3	work you've put in to help bring this together.	3	application of the Indus Waters Treaty. So all the site
4	And I'm sure I'm missing individuals or parts of the	4	experts can rest assured: we are not asking you any
5	government, but please take thanks from the Court of	5	questions about the law. We're solely interested in
6	Arbitration to everyone who's had a part in this	6	some of the facts relating to this particular dam site.
7	process.	7	My fourth point: all presentations by the site
8	Let me also note, with regret, the absence of the	8	experts are intended to be succinct, neutral, solely
9	Government of India at this site visit. The court would	9	technical in nature, and are presented by individuals
10	like to recall that it invited India almost a year ago	10	who are not members of the Government of Pakistan's team
11	to participate in the site visit process, and would have	11	or experts appearing before the court.
12	welcomed and benefited from its involvement in the	12	Fifth, the court's questions to the site experts
13	process, both in reacting to presentations being made by	13	will be exclusively on technical matters presented, and
14	the site visit experts here, but also we would have	14	we will not stray into any legal issues.
15	liked to visit sites in territory administered by India.	15	Sixth, at any time during a technical presentation
16	We would have benefited from hearing presentations from	16	or after it, members of the court may have questions for
17	India's site experts about their work and their dams,	17	the experts. So I hope you don't mind us occasionally
18	and so we hope that India will at some point decide to	18	interrupting you with something that we just don't quite
19	engage in this process. It would greatly assist the	19	understand, and we would welcome your response. I take
20	Court of Arbitration if they were to do so.	20	the point that there may be some questions that you're
20	I'll note something that the engineers don't need to	20	not able to respond; that's entirely fine. Do your
21	pay attention to, but India has not indicated	21	best, we expect nothing more than that.
22	an intention to file a counter-memorial in our process.	22	Seventh, once a technical presentation is completed,
23 24	So the next step in our process is a hearing on the	23	to the extent that Pakistan's deputy agent or lead
24	merits regarding what we call "phase 1 issues", which	24	counsel believes that it would be helpful to the court
23	ments regarding what we can phase I issues, which	23	counsel beneves that it would be neipitil to the court
	Page 9		Page 11
1	will be in mid-July. The court would certainly welcome	1	for a succinct and non-leading question to be put to the
2	participation by India in that hearing if they are able	2	technical expert for purposes of clarification or
2 3	participation by India in that hearing if they are able and willing to do so.	2 3	technical expert for purposes of clarification or correction, then the deputy agent or the lead counsel
2 3 4	participation by India in that hearing if they are able and willing to do so. I will also note that this site visit is not is	2 3 4	technical expert for purposes of clarification or correction, then the deputy agent or the lead counsel will direct the question to me, and the court will
2 3 4 5	participation by India in that hearing if they are able and willing to do so. I will also note that this site visit is not is not an ex parte visit. Under Article 10.4 of the	2 3 4 5	technical expert for purposes of clarification or correction, then the deputy agent or the lead counsel will direct the question to me, and the court will decide whether or not to pursue the matter.
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1	sessions and the technical presentations, the members of	1	we see the Kishenganga project over there, with the
2	the court and the Neutral Observer on the one hand, and	2	yellow, which is functioning right there. And with
3	the representatives and site experts of Pakistan on the	3	their tunnel as well, it is performing a similar
4	other hand, may exchange cordial greetings. But there	4	function as I told earlier in the NJHEP project.
5	shall be no substantive exchanges, either technical or	5	South of that is the upper limb of Jhelum River, and
6	legal in nature.	6	you can see Sirinagar as well. This Jhelum River
7	Finally, let me return to the presence of Mr Pomper	7	discharges into and then emerges out of Wular Lake,
8	as our Neutral Observer. His task is to be present	8	located in India. And downstream of Wular Lake, you can
9	throughout the site visit, to observe the proceedings	9	see the Lower Jhelum project by India, the Uri 1 and
10	and the overall conduct of the visit. He will alert me	10	Uri 2 projects.
11	during the site visit if he has concerns in that regard,	11	Once again, crossing the red line of control, we can
12	in which case I will address the matter promptly. He	12	see Siran over here, the red triangle. It is our
13	will then certify, at the end of the site visit, that it	13	forthcoming hydroelectric project which Pakistan is in
14	was or was not conducted in accordance with the	14	process of constructing. And once more, you see a route
15	protocols set out in Protocol Order No. 10.	15	of tunnel over here, which removes water from Jhelum
16	Unless there are any further issues to be raised,	16	Upper Limb, and discharges it back into the Jhelum again
10	the court is ready to receive the first presentation.	17	downstream of Muzaffarabad.
17	(A short break)	18	Slide 6, please.
10	Presentation 1: NJHEP General Orientation	19	THE CHAIRMAN: Mr Joya, before you leave this slide, can
20		20	I ask you to point out on the slide where the power
20	MR JOYA: So I will now give you a short introduction of	20	station is located.
21	NJHEP, with a view to situating you for the	21	MR JOYA: So the NJHEP, we start from the headworks. The
22	presentations to come.	22	
23 24	Slide 5, please. On the slide, we have a map of the	23 24	power station comes right after crossing the Neelum
	surrounding area, with major cities and hydropower	24 25	River Jhelum River right over here somewhere. That
25	features. I shall start from left of the site; that is	23	will come in detail later on, sir.
	Page 13		Page 15
1	Muzaffarahad Vau can saa Muzaffarahad ayar hara. This	1	THE CHAIDMAN. So it's right on that part of the river?
1	Muzaffarabad. You can see Muzaffarabad over here. This	1	THE CHAIRMAN: So it's right on that part of the river?
2	is the place where we are right now.	2	MR JOYA: Yes, it's here.
2 3	is the place where we are right now. Muzaffarabad is the intersection of two rivers. One	2 3	MR JOYA: Yes, it's here. THE CHAIRMAN: And second question is: as we go up here
2 3 4	is the place where we are right now. Muzaffarabad is the intersection of two rivers. One is called Neelum River, which is known as Kishenganga as	2 3 4	MR JOYA: Yes, it's here. THE CHAIRMAN: And second question is: as we go up here along the river, I looked down at a certain point and
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1		1	Si'de 10 where the south one interference the
1	poor geology of this area. So instead of going for	1	Slide 10, please. It's another view from the
2	a single larger [one] there, we have to go for two	2	downstream side, to make things for the completeness of
3	smaller ones, to cater for the geology of the area,	3	purpose. From this angle, the orifice spillway is
4	based on recommendation of the designers.	4	completely submerged into water over here, whereas you
5	At the lower parts, you can see the powerhouse where	5	can see the crest-gated spillway over here; and these
6	the turbines and generators are located. And from	6	are its gates, which are operated over here.
7	there, as I told earlier, is the tailrace you can see at	7	This image also gives a clear view of the freeboard.
8	the bottom. It will come in more detail later on, sir.	8	Freeboard is a structure extended above the surface
9	Slide 7. So it's about the headworks. On the slide	9	level of the reservoir, you can see over here.
10	I will explain three things. Number 1 is the reservoir;	10	Slide 11, please. There is more about NJHEP
11	number 2 is the dam wall; and number 3, the Neelum River	11	powerhouse site. Turning now towards the powerhouse,
12	flowing from south to north. These things are coming in	12	this is a satellite image of it, obviously not showing
13	detail in the forthcoming slides, sir.	13	the powerhouse itself it is only denoted by a word
14	Slide 8, please. Now I have tilted the previous	14	"P" which is well below the surface.
15	slide at 90 degrees to give a more clear picture, sir,	15	Same may be said to the headrace and tailrace, which
16	of the area. This shows the design in a little more	16	run from top right to the bottom left. Running through
17	detail with the key elements picked out. This image	17	the powerhouse, ultimately these enter into the Jhelum
18	will be revisited in many presentations which will come	18	River to discharge water.
19	after me by other presenters. It is included over here	19	What you can see, however, is the switchyard above
20	just to familiarise you with the orientation of the	20	the ground, to connect the power to our national grid
21	project.	21	from here.
22	As I told earlier, it's the previous slide: it has	22	Sir, slide 12, please. Now the powerhouse. If we
23	been turned at a 90-degree angle. It shows the Neelum	23	were to excavate the area around the powerhouse, you
24	River flowing from left to right. And the dam wall is	24	would find something very much like this. In maroon,
25	shown in yellow, and its associated structures in	25	this one, we can see the powerhouse itself. The
		_	-
	Page 17		Page 19
1	brownish over here.	1	slightly larger triangle, this one, is power station
2	Then there are two spillways, shown in red and in	2	house. It is housing the generators, so we call it
2 3	Then there are two spillways, shown in red and in purple. And dissipation structure, and you can see	2 3	house. It is housing the generators, so we call it "generator hall" as well; whereas the slightly smaller
2 3 4	Then there are two spillways, shown in red and in purple. And dissipation structure, and you can see a brownish colour. Then you can see the stilling basin	2 3 4	house. It is housing the generators, so we call it "generator hall" as well; whereas the slightly smaller one is the transformer hall, where the step-up
2 3 4 5	Then there are two spillways, shown in red and in purple. And dissipation structure, and you can see a brownish colour. Then you can see the stilling basin over here; the "desanders", it's called. It's	2 3 4 5	house. It is housing the generators, so we call it "generator hall" as well; whereas the slightly smaller one is the transformer hall, where the step-up substations are located to ready the current for
2 3 4 5 6	Then there are two spillways, shown in red and in purple. And dissipation structure, and you can see a brownish colour. Then you can see the stilling basin over here; the "desanders", it's called. It's a desander structure, with the structure which is shown	2 3 4 5 6	house. It is housing the generators, so we call it "generator hall" as well; whereas the slightly smaller one is the transformer hall, where the step-up substations are located to ready the current for transmissions. You will see it later on as well.
2 3 4 5 6 7	Then there are two spillways, shown in red and in purple. And dissipation structure, and you can see a brownish colour. Then you can see the stilling basin over here; the "desanders", it's called. It's a desander structure, with the structure which is shown in pink. It is the operating building. And then,	2 3 4 5 6 7	house. It is housing the generators, so we call it "generator hall" as well; whereas the slightly smaller one is the transformer hall, where the step-up substations are located to ready the current for transmissions. You will see it later on as well. More than that, there's a system of penstocks. You
2 3 4 5 6 7 8	Then there are two spillways, shown in red and in purple. And dissipation structure, and you can see a brownish colour. Then you can see the stilling basin over here; the "desanders", it's called. It's a desander structure, with the structure which is shown in pink. It is the operating building. And then, finally, there's a headrace tunnel, which comes in	2 3 4 5 6 7 8	 house. It is housing the generators, so we call it "generator hall" as well; whereas the slightly smaller one is the transformer hall, where the step-up substations are located to ready the current for transmissions. You will see it later on as well. More than that, there's a system of penstocks. You know that penstock, these are the pipes which take water
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1	(indistinct). We have shown powerhouse here in detail.	1 4.4 kilometres more tailrace, it discharges into the
2	Other presenters will take you back to this again and	2 Jhelum River.
	1 2	
3	again, so I will just give an overview of this slide,	
4	sir.	4 your kind attention. You will see all these elements
5	As you can see, we have two main halls. One is	5 close up over the coming days, and these elements will
6	a larger one, the other is a smaller one. The larger	6 be discussed separately as well by the experts. The
7	hall is a generator hall, whereas the smaller one is the	7 purpose of this brief presentation was simply to
8	transformer hall, which I showed earlier in red colour,	8 orientate you what is to come. So if you have
9	sir. Then beneath the generator hall we have	9 questions, I am over here, sir, at your disposal.
10	a structure of turbines, which stretches over the four	10 THE CHAIRMAN: I have one question. It's probably of no
11	floors.	11 great significance, but I'm curious about the exact
12	We can see third generator unit over here. Then	12 location of the power station. So if we go back to
13	there's a connecting shaft to the turbine over here.	13 slide 17 for just a minute, it looks like the powerhouse
14	The turbine is shown, sir, in yellow, whereas the	is relatively close to the tailrace area. And yet if we
14	•	15 go to slide I think it's 11, it looks as though the
	distinctive scroll case, that is shown in red. It's the	• •
16	point where the water enters into the turbines to run	16 powerhouse is rather far from the tailrace. So if you
17	this. Then this water is disposed to a draft tube over	17 could just clarify that.
18	here.	18 MR JOYA: It's only you can see it's a satellite image.
19	Slide 14. The only thing which is above the ground,	19 We have blown it up just to show the tailrace area more
20	that is the NJHEP switchyard, which you can see over	20 clearly. On the same scale, if I show the headrace as
21	here, sir. And it will be shown to you during your site	21 well, then well you can compare both areas.
22	visit as well.	22 THE CHAIRMAN: So I think my confusion was: it almost looks
23	Slide 15. This is the NJHEP tailrace discharge	23 like that's the upper part of the Jhelum River. But
24	tunnel. It comes over here and discharges into the	that's not the case: that's just a divide in the
25	Jhelum River, which comes this way. I think you might	25 topography, yes.
_		
	Page 21	Page 23
1	have seen it while coming on the way to Muzaffarahad	1 MR IOYA: It's just to show the tailrace more clearly
1	have seen it while coming on the way to Muzaffarabad,	1 MR JOYA: It's just to show the tailrace more clearly. 2 Otherwise length is the same 3.4 kilometres as
2	sir.	2 Otherwise length is the same, 3.4 kilometres, as
2 3	sir. THE CHAIRMAN: Yes.	 Otherwise length is the same, 3.4 kilometres, as I showed earlier, sir.
2 3 4	sir. THE CHAIRMAN: Yes. MR JOYA: Slide 16, please. So this is the NJHEP hydraulic	 Otherwise length is the same, 3.4 kilometres, as I showed earlier, sir. THE CHAIRMAN: I understand. Thank you very much.
2 3 4 5	sir. THE CHAIRMAN: Yes. MR JOYA: Slide 16, please. So this is the NJHEP hydraulic profile. When we pull out all this together, you get	 Otherwise length is the same, 3.4 kilometres, as I showed earlier, sir. THE CHAIRMAN: I understand. Thank you very much. MR JOYA: You're welcome, sir.
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1	and forth. The order of presentations will remain the	1 On Day 3, the objective is to depart from
2	same.	2 Muzaffarabad after the presentation at around 5.00 pm,
3	Once I have described the schedule, I will hand back	3 returning in time for closing the day, and for the
4	to Mr Joya for the final limb of this introductory	4 dinner and other activities like that.
5	presentation, being the introduction of the speakers.	5 Next slide, please (21). With Day 4 now being
6	I should add, the schedule is subject to change, maybe	6 occupied with presentation no. 7, the dam and reservoir
7	because of some weather conditions. Thank you very	7 inspection, the presentation[s] of Day 4 [have] been
8	much.	8 moved to Day 5.
9	Our next slide, please (19). Day 1 was yesterday,	9 It is another long day, taking place entirely at the
10	and so we are at the start of Day 2. It is a shorter	10 powerhouse. We will depart from Muzaffarabad at 9.15,
11	day, with two presentations only. The first one is this	11 travelling downstream this time, arriving at the
12	one which is being currently made.	12 powerhouse at around 10.15.
13	It will be followed by presentation no. 2, which	13 There will be four presentations over the course of
14	will start diving a little deeper into the higher level	14 the afternoon: presentation no. 8, which is general site
15	features of the run-of-river hydroelectric plants,	15 orientation; presentation no. 9, which is basics of
16	specifically on Himalayan rivers. Design, construction	16 powerhouse; presentation no. 10, which is on power
17	and operation issues will be examined in brief.	17 production; and presentation no. 11, which is the
18	After that, the court will be able to identify any	18 inspection of the powerhouse itself. The court will
19	specific questions or issues that it wishes to see	19 then have the opportunity to deliberate on-site before
20	addressed on the following days.	20 issuing the instructions for Day 5.
21	Next slide, please (20). As you can see from the	21 The object is to depart from Muzaffarabad at around
22	slide, Day 3 was intended to be a long day at the dam	5.00 pm, arriving back again in time back to the hotel.
23	site. The schedule for this day has been modified	23 Next slide, please (22). The events of Day 5 have
24	a bit. We will depart early from Muzaffarabad, at	been moved to Day 6, as I said earlier, which was
25	8.00 am in the morning, aiming to arrive at the dam	25 originally the first contingency day. The Day 6 agenda
	Page 25	Page 27
1	site, some 44 kilometres upstream, at around 9.30 am in	1 is to be sent by the court. Once you have given us your
1 2	site, some 44 kilometres upstream, at around 9.30 am in the morning.	2 directions, we will work with you to provide a schedule
	the morning. We will then have four presentations over the course	2 directions, we will work with you to provide a schedule3 for this day.
2 3 4	the morning. We will then have four presentations over the course of the morning and afternoon, which are the site	 directions, we will work with you to provide a schedule for this day. Next slide, please (23). The events of Day 6 have
2 3	the morning. We will then have four presentations over the course of the morning and afternoon, which are the site orientation, the presentation no. 3, to enable you to	 2 directions, we will work with you to provide a schedule 3 for this day. 4 Next slide, please (23). The events of Day 6 have 5 been moved to Day 7. It is currently listed as
2 3 4 5 6	the morning. We will then have four presentations over the course of the morning and afternoon, which are the site orientation, the presentation no. 3, to enable you to see the physical layout of the dam site before we go on	 directions, we will work with you to provide a schedule for this day. Next slide, please (23). The events of Day 6 have been moved to Day 7. It is currently listed as a contingency day in case of some inclement weather
2 3 4 5 6 7	the morning. We will then have four presentations over the course of the morning and afternoon, which are the site orientation, the presentation no. 3, to enable you to see the physical layout of the dam site before we go on to the conference room for the detailed presentations.	 directions, we will work with you to provide a schedule for this day. Next slide, please (23). The events of Day 6 have been moved to Day 7. It is currently listed as a contingency day in case of some inclement weather conditions or other interruption preventing some proper
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1	decision that the timing would be optimised by having	1	We have another two members from NJHEP team:
2	the two days is certainly agreeable to the court. And	2	Mr Arfan Miana and Ayub [Malik]. Mr Miana, sir, please.
3	we're also aware that weather conditions may affect	3	Mr Miana has bachelor's and master's degree in
4	sequencing here, and we certainly are amenable to that	4	mechanical engineering, and has worked with WAPDA since
5	as well.	5	1992. He was involved in commission of 1,410 MW Tarbela
6	Any questions from anyone about the itinerary? No	6	4th Extension. He has been project director over there,
7	questions then beyond that. Thank you so much.	7	and currently he is chief executive officer here at and
8	MR JOYA: Thank you very much, Mr Ghani, for giving me	8	NJHEP.
9	a chance to speak again.	9	And Mr Malik, he has bachelor's degree in civil
10	Slide 27, sir. It's about the presenters to come	10	engineering and a master's degree in irrigation
11	here. Members of the court, Pakistan has assembled	11	engineering. He has 34 years of experience in
12	a range of hydropower experts from many different	12	construction management and contract administration,
13	organisations within Pakistan. Many of them work at	13	particularly in relation to the megaprojects. He is
14	NJHEP and other hydropower facilities, both operational	14	presently deputy project manager of NJHEP.
15	and under construction, throughout Pakistan. So they	15	Slide 29, please. So that's our next group of
16	are now under the umbrella of WAPDA and in this house	16	presenters: Mr Fiaz Hanif, Mr Umar Farooq and Mr Nayyar
17	here as well, the experts.	17	Alauddin.
18	We also have two representatives with us from	18	At the top is Mr Fiaz Hanif Sendhu, over here. He
19	NESPAK. NESPAK is National Engineering Services of	19	is our geology expert. He holds bachelor's degree and
20	Pakistan, a government enterprise, an energy contractor	20	master's degree in geology and geohydrology, as well as
21	which provides consulting, construction, engineering and	21	a further master's degree in hydrology. He has 35 years
22	management services globally. Its headquarters is at	22	of experience in the field of hydropower, and presently
23	Lahore. It's one of the largest engineering consultant	23	he is chief geologist of 1,530 MW Tarbela 5th Extension
24	management companies in Africa and Asia as well. They	24	project.
25	are with us in this room.	25	Then we have Mr Umar Farooq, who is the senior
	Page 29		Page 31
1	As I point out on the slide, I would ask them to	1	engineer in the Water & Agric division of NESPAK. He
2	As I point out on the slide, I would ask them to raise their hands so as we can identify them. Thank	2	holds a bachelor's degree in civil engineering and
2 3	raise their hands so as we can identify them. Thank you.	2 3	holds a bachelor's degree in civil engineering and master's degree in hydraulic and irrigation engineering.
2 3 4	raise their hands so as we can identify them. Thank you. So in front of you, sir, are the group of presenters	2 3 4	holds a bachelor's degree in civil engineering and master's degree in hydraulic and irrigation engineering. He is in the process of completing his doctorate on
2 3	raise their hands so as we can identify them. Thank you. So in front of you, sir, are the group of presenters number 1. Mr Ghani, the chairman of WAPDA,	2 3	holds a bachelor's degree in civil engineering and master's degree in hydraulic and irrigation engineering. He is in the process of completing his doctorate on water source engineering.
2 3 4	raise their hands so as we can identify them. Thank you. So in front of you, sir, are the group of presenters	2 3 4	holds a bachelor's degree in civil engineering and master's degree in hydraulic and irrigation engineering.He is in the process of completing his doctorate on water source engineering.Mr Nayyar Alauddin. So Mr Alauddin has a bachelor's
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1	a doctorate in civil engineering.	1	project, and he'll be making part of the presentation,
2	Mr Hameedullah Khan, he has a bachelor's degree in	2	the latter half.
3	electrical engineering, and currently he is serving as	3	So we have been asked to make the first substantive
4	chief engineer at Warsak HEP, which is undergoing	4	presentation of the site visit on hydroelectric
5	intensive rehabilitation these days.	5	projects, "HEP" for an acronym. And you will hear a lot
6	Mr Arshad Malik. He holds bachelor's and master's	6	of this "HEP", "HEP", and this is basically
7	degrees in electrical engineering. He has deep	7	hydroelectric project: design, construction and
8	experience in thermal and hydropower throughout	8	operation.
9	Pakistan, including as an additional chief engineer at	9	This presentation is intended as an introduction to
10	the NJHEP as well. He is currently a chief engineer at	10	the design and development process behind the
11	WAPDA's hydropower projects.	11	run-of-the-river hydroelectric project on a Himalayan
12	So that concludes this introductory presentation on	12	river, and the presentation will be basically in four
13	behalf of Chairman Ghani, WAPDA, and the staff of NJHEP.	13	parts.
14	Thank you, sir, for your kind attention, and we wish you	14	So in the first part, I will provide you with
15	a very successful site visit. If you again have some	15	an overview of the HEP development process, setting out
16	questions, we are at your disposal on this.	16	the various challenges that its designer and others
17	THE CHAIRMAN: I don't think we have questions, but I do	17	associated with it will face, and eventually and
18	want to thank you for those introductions. They were	18	hopefully overcome as part of that process.
19	very helpful, and I feel like there's a lot of degrees	19	Secondly, I will address the question of HEP
20	in this room! It's very impressive, and we're very	20	development, explaining how we start from a blank sheet
21	grateful for all the time that you've taken to help put	21	of paper and actually design through various stages and
22	together this very distinguished cast of experts. So	22	phases to a design which can be put into practice by the
23	thank you, Mr Joya, and thank you to everyone.	23	contractor, and thus have a fully functional hydropower
24	MR JOYA: Sir, thank you. With this, we are proceeding	24	project.
25	towards a break for coffee, if you like, sir.	25	Thirdly, Mr Malik will explain the HEP itself,
	·		
	Page 33		Page 35
1	THE CHAIRMAN: Absolutely.	1	taking you through its major components and explaining
2	MR JOYA: And then we'll come back after ten minutes for	2	how these fit together. And again, in the last part,
2 3	MR JOYA: And then we'll come back after ten minutes for presentation no. 2 in the same [room].	2 3	how these fit together. And again, in the last part, Mr Malik will give you an overview of the HEP
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1		1	menoretion tondoring menored and hid evolvation and
1	operated successfully, any megaproject must overcome numerous hurdles across multiple dimensions. And when	1 2	preparation, tendering process and bid evaluation, and
2 3	you are talking about the Himalayan region, all these	3	negotiation and award.
4	hurdles are magnified.	4	So these processes may take many months and involve
			experts like advisors, lawyers, in-house and external,
5	With that, sir, slide number 3, please. We'll talk	5	to go through all these processes. So the early steps
6	now about the HEP development process.	6	are typically carried out in parallel of the feasibility
7	And slide 4. So at the centre of this diagram, you	7	studies or pre-feasibility studies. And then, later on,
8	see the HEP design, which actually is HEP development,	8	during the next phases, these are refined. And during
9	let's call it. And it entails basically six main	9	this process, the assistance is also taken from
10	components of design.	10	internationally recognised construction precedents, such
11	The first one is the technical studies and	11	as those produced by FIDIC, which is the International
12	engineering. And as we move clockwise, it's: contractor	12	Federation of Consulting Engineers.
13	selection and contracting; social impact assessment,	13	Now, FIDIC produces typical templates of multiple
14	resettlement and compensation; environmental impact	14	contracts. But the most important of these for the
15	assessment, mitigation and management; regulatory	15	purpose of the HEPs are the Red Book, which is
16	activities, power planning and power sales; and, of	16	applicable to large construction projects generally; the
17	course, financial planning and financing.	17	Yellow Book, which deals with electrical and mechanical
18	Now, these six processes, they must run in parallel,	18	works; and the Silver Book, which deals with what I just
19	and they start almost from the conception stage, to	19	said: EPC, or engineering procurement and construction,
20	a certain degree. And then they are refined and more	20	which is basically a turnkey project. So these are the
21	detailed as the process goes along. And these must be	21	internationally recognised templates which, with some
22	carried [out] in parallel. And failure of any one of	22	modification, people normally use to make these tenders.
23	these could mean the failure of the project, or its	23	Slide 7, please. Next we have the social impact of
24	prolongation, or it's been put in "cold storage", as you	24	the project. So no project is without social impacts.
25	may call it. So all these are important. And I will	25	These social impacts are usually measured using a range
	Page 37		Page 39
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1	take you through each of these later in the	1	of internationally recognised standards, such as the
1 2	take you through each of these later in the presentation.	2	Equator Principles or the standard guidelines which are
			Equator Principles or the standard guidelines which are produced by institutions such as the International
2	presentation.	2	Equator Principles or the standard guidelines which are
2 3	presentation. Let's look at slide 5, please. So here we have the design phases of hydroelectric power project, HEP. They go from concept, to pre-feasibility, to feasibility,	2 3	Equator Principles or the standard guidelines which are produced by institutions such as the International Finance Corporation or World Bank or the Asian Development Bank.
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1	Restoration of resettlement and livelihood. So we	1	a project failure or its being put into cold storage.
2	make better villages, give them better facilities; so	2	The project is okay, everything is fine, all the
3	whatever they had before, they will have a much better	3	indicators are good, yet you don't have the money to
4	life in that area. And payment of compensation, of	4	build it. Then it will be put into cold storage.
5	course, for their movement and all of the things. But	5	So as the slide shows, it starts with financial
6	if no mitigation is possible, however, then the site	6	analysis and tariff analysis, which is basically how
7	would be basically unsuitable.	7	much it's going to cost to build, obtain all the
8	And by the way, if the social impacts of the	8	permits, all the resettlements, all the costs,
9	projects are not managed, the project will fail at the	9	everything included; and what are the tariffs and what
10	very least, and become more challenging to implement,	10	are the returns that you're going to get. So is that
11	including because the investors and lenders will be shy	11	positive? Is the EIRR, FIRR, all the economists, they
12	to support such a project. So if the project backers	12	do all those things, and cost-benefit ratio. So if that
13	insist on pushing on the project regardless of the	13	is positive then the project is positive.
13	legitimate objections of the locals, then they will find	14	THE CHAIRMAN: Dr Hayat, can I just ask you a question?
15	it very hard to get international or private funding.	15	When you say "tariff analysis", we're speaking about the
16	Slide 8, please. So the environmental impacts are	16	tariffs in essentially selling the power from the plant?
10	also similar in nature, somewhat. And this details some	10	DR HAYAT: Selling the power to a utility or to the
17	of them, like impact on wildlife, which is flooding of	17	government, sir.
			THE CHAIRMAN: Thank you.
19 20	natural habitats, possibly including some endangered	19 20	•
20	species; effects on fish and other aquatic life,	20	DR HAYAT: Yes, sir.
21	floating aquatic vegetation, loss of terrestrial	21	So then there are options that are available to the
22	wildlife.	22	builders, whether they go for debt funding options or
23	Wider impacts could be downstream hydrological	23	they go for equity funding, or there could be a mixed
24	changes due to stream flow, sediment transport, water	24	bag. And then they have to go for financing agreements
25	quality, because there will be reduced flow downstream,	25	with various agencies to secure all the funds that are
	Page 41		Page 43
	-		-
1	reservoir sedimentation, greenhouse production from	1	required before they actually embark on the
1 2	reservoir sedimentation, greenhouse production from reservoirs, and waterborne diseases.	12	required before they actually embark on the construction. And these are all so final stage is of
2	reservoirs, and waterborne diseases.	2	construction. And these are all so final stage is of
2 3	reservoirs, and waterborne diseases. There are again potential mitigation strategies	2 3	construction. And these are all so final stage is of course negotiations, signatures of financial agreements,
2 3 4	reservoirs, and waterborne diseases. There are again potential mitigation strategies available. For example, we select an appropriate site	2 3 4	construction. And these are all so final stage is of course negotiations, signatures of financial agreements, and all that.
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1	So PPA can either be for a predefined amount of	1	a cascade of facilities, or was it seen more as
2	energy or a predefined percentage of energy that the HEP	2	a standalone facility?
	will eventually generate.	3	DR HAYAT: At this point in time, it is a standalone. But
3			there are possibilities of sites downstream which could
4	Beyond PPA, there are of course other instruments	4	*
5	that the project will need to obtain. So there are land	5	make into a cascade. But, you see, if you see all the
6	acquisition agreements. The land that is inundated, or	6	projects because Neelum or Kishenganga is only part
7	the land that is required for building the dam or the	7	of the river: it joins Jhelum. So in that sense, it is
8	reservoir area which is inundated, it could be	8	part of Jhelum also. And on Jhelum, you have Kohala,
9	government land: then you will need government	9	you have many other projects before you hit Mangla: you
10	permission. If it is private land, you'll have to talk	10	have Mahl, you have Karot, and all those other projects.
11	to the private owners and give them compensation. So	11	So it can be considered as a part of a cascade also in
12	all those agreements have to be in place.	12	that sense.
13	And water right agreements, because you will be	13	DR BLACKMORE: Thank you.
14	using water of the river. So agencies will be	14	MR MINEAR: Excuse me, Mr Hayat, now that we've interrupted
15	responsible for the water of the river, and you'll have	15	you, can I ask: are water rights in Pakistan
16	to go to those agencies to get the permit that, "I want	16	administered at the national, regional or local level?
17	to use this water for building the dam", because there	17	DR HAYAT: To my understanding I think I will refer this
18	will be some storage for some time. The effect is not	18	to one of my colleagues here, and I will come back to
19	that much for a run-of-the-river project, but it is more	19	you later on that. But very briefly, I think both the
20	for a storage dam. But in any case, you need water	20	provinces and the central government gets involved in
21	rights agreements.	21	this. But we will clarify that more in detail as we go
22	And you need project implementation and concession	22	along.
23	agreements, and mostly the government agencies are	23	MR MINEAR: Thank you.
23	responsible for this. And any other necessary permits.	23	THE CHAIRMAN: I have a question that relates to contractors
24	So with this review, you'll be able to see the	25	that you discussed. And again, if you're not in
23	so with this review, you'll be able to see the	25	that you discussed. And again, if you're not in
	Page 45		Page 47
1	reality. I mean, going through all of this is not easy.	1	a position to answer that's fine. But I'm just curious
1	reality. I mean, going through all of this is not easy, to say the least. This is some exercise that you have	1	a position to answer, that's fine. But I'm just curious whether as a general proposition, there's a limited
2	to say the least. This is some exercise that you have	2	whether, as a general proposition, there's a limited
2 3	to say the least. This is some exercise that you have to carry out. I see some smiles on some faces here!	2 3	whether, as a general proposition, there's a limited number of contractors global contractors that do
2 3 4	to say the least. This is some exercise that you have to carry out. I see some smiles on some faces here! And as I said earlier, it is lengthy, it is expensive	2 3 4	whether, as a general proposition, there's a limited number of contractors global contractors that do this kind of work, or whether it's a very fragmented
2 3 4 5	to say the least. This is some exercise that you have to carry out. I see some smiles on some faces here! And as I said earlier, it is lengthy, it is expensive and it is challenging. And with that said, it is not	2 3 4 5	whether, as a general proposition, there's a limited number of contractors global contractors that do this kind of work, or whether it's a very fragmented population that you can sort of pick and choose from?
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1	of the contract which the civil contractor takes up, and	1	process will determine whether it is worthwhile even
2	then you have the electrical, which maybe another person	2	considering the site for hydropower production. I mean,
3	or another entity. And then the hydromechanical, like	3	if you have stream gauging normally it is there in
4	gates and other things, they go to another party, and	4	Pakistan and all the other countries also you have
5	they come and join hands. Or maybe sometimes even the	5	the data on river flows throughout the year, and
6	designers or the client, let's say WAPDA, they also	6	normally spanning many decades: 60, 70, 80, sometimes
7	sometimes package them differently, so they are not let	7	more than 100 years. So you know how much water is
8	out as one single contract.	8	coming in that stream, and whether it is viable to
9	For example, in Diamer Basha, we are making six	9	actually put hydropower in there. Is there firm water
10	contracts, which is main works 1, main works 2,	10	available throughout the year, or most part of it?
11	hydromechanical 1, hydromechanical 2,	11	So at the concept stage, the power demand that the
12	electrical-mechanical 1, electrical-mechanical 2; so six	12	project will aim to meet will also need to be
13	contracts. So it depends on various scenarios and how	13	identified. And once the site is selected, a desk study
14	you want to proceed.	14	to develop the concept is undertaken, which will involve
15	Does that answer your question?	15	selecting the basic design of the HEP, together with its
16	THE CHAIRMAN: Thank you, yes, very helpful.	16	proposed capacity.
17	DR HAYAT: Thank you, sir.	17	So basic design and proposed capacity, and
18	So we have looked at the challenges in HEP	18	developing the basic operational procedures that will
19	development. Now, let's look at how the design process	19	determine the concepts, energy generation and daily
20	functions from concept to execution.	20	income in very broad it's like a broad brush, you
21	You will recall that we set out five stages of HEP	21	know. It's the early stages. So that is the concept.
22	design by way of introduction. Now I will examine them	22	If the resulting concept is sufficiently positive,
23	in slightly more detail. Obviously there are different	23	then the HEP designer will set down a budget for future
24	methodologies, but this is the generic one that I will	24	development. It all boils down to money that you have
25	be explaining.	25	to spend, you know, eventually. So you have to see: is
	Page 49		Page 51
1	Slide 12. Project conception. So this is basically	1	it worthwhile going ahead on this one? At each step you
1 2	Slide 12. Project conception. So this is basically a desk study, and this is where you conceive a project.	1 2	it worthwhile going ahead on this one? At each step you ask that question as you go along the process.
2	a desk study, and this is where you conceive a project.	2	ask that question as you go along the process.
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2 3	a desk study, and this is where you conceive a project. And this is done, for instance, first time, by screening the national inventory.	2 3	ask that question as you go along the process. But the most important decision that has to be made at this stage is whether a hydroelectric plant will be
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		1	
1	Delvision for example. New need water for importion	1	magazine that you are at a and has isally your tail you ta
1	Pakistan, for example. You need water for irrigation.	1	reservoir that you create, and basically your tail water
2	So you need that also in the dry months when only the	2	level. So higher the head, higher will be the energy
3	river flow is not sufficient to meet all the demands.	3	that you will produce because it will give you that much
4	Therefore, at that point in time you use the water that	4	higher pressure at that.
5	you have stored in the reservoir during your wet months,	5	And the other variable in that is the amount of
6	and use it during the dry months for your irrigation	6	water, the volume of water in cubic metres per second
7	needs and your power generation.	7	that you flow through the turbines. So higher the flow
8	Second are the run-of-the-river projects. These are	8	through the turbine, higher will be the energy that you
9	only used for generation of electricity or power. In	9	will produce. If you have higher volume of water and
10	general, very broad terms, in a run-of-the-river	10	higher head, it is very good, you will be able to
11	project, the water coming into the river is equal to the	11	produce very good electricity.
12	water that goes out of the power station back into the	12	So an engineer who is actually designing a project,
13	river. So that is, in very broad terms,	13	or the financer or anybody that is backing the project,
14	a run-of-the-river project, unless the water coming in	14	he would like to maximise the power potential of a site.
15	the river is more than what is required at the power	15	That is natural because you want to get the maximum
16	plant. In that case, as you see in the Neelum-Jhelum,	16	money out of your project, you want to get the best
17	we have spillways: you can spill over back into the	17	return on your project. Now, in a storage project, this
18	river.	18	is usually done by creating a tall dam or a very high
19	However, since these plants are basically for power	19	dam. As I said, in Basha we are creating
20	generation, and power generation is and power demand	20	272 metres-high dam, with a very high storage.
21	actually, power demand, I would say, is variable during	21	So that is the head that is available at the dam
22	the day. During the night, when people sleep, the power	22	site. So that is used for storage, and you use that
23	demand goes down. And during the day, when people	23	head with a high dam to produce electricity, because
24	start, and businesses start opening, factories start and	24	higher the head, you produce more electricity.
25	everything, the power demand surges. So in a 24-hour	25	In a run-of-the-river project, a massive reservoir
23	everything, the power demand surges. So in a 24-nour	23	in a run-or-me-river project, a massive reservoir
	Page 53		Page 55
1		1	
1	day period, there are ups and downs in power demand.	1	is not needed. The necessary head can be created
2	Therefore, a small reservoir is needed as	2	through a low dam with a small reservoir, and which is
2 3	Therefore, a small reservoir is needed as an operational pool. So that during the lower demand	2 3	through a low dam with a small reservoir, and which is connected to the turbine via a tunnel, in a descending
2 3 4	Therefore, a small reservoir is needed as an operational pool. So that during the lower demand period, you will store enough water in that small	2 3 4	through a low dam with a small reservoir, and which is connected to the turbine via a tunnel, in a descending tunnel.
2 3	Therefore, a small reservoir is needed as an operational pool. So that during the lower demand	2 3	through a low dam with a small reservoir, and which is connected to the turbine via a tunnel, in a descending
2 3 4 5 6	Therefore, a small reservoir is needed as an operational pool. So that during the lower demand period, you will store enough water in that small	2 3 4	through a low dam with a small reservoir, and which is connected to the turbine via a tunnel, in a descending tunnel. So you use the topography, which in Himalayas is quite steep. So you have a small reservoir, and you
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2 3 4 5 6	Therefore, a small reservoir is needed as an operational pool. So that during the lower demand period, you will store enough water in that small reservoir or pondage so that, during the high demand period, you will release that water that you have stored	2 3 4 5 6	through a low dam with a small reservoir, and which is connected to the turbine via a tunnel, in a descending tunnel. So you use the topography, which in Himalayas is quite steep. So you have a small reservoir, and you
2 3 4 5 6 7	Therefore, a small reservoir is needed as an operational pool. So that during the lower demand period, you will store enough water in that small reservoir or pondage so that, during the high demand period, you will release that water that you have stored in that 24-hour period into the power station to generate more electricity.	2 3 4 5 6 7	through a low dam with a small reservoir, and which is connected to the turbine via a tunnel, in a descending tunnel.So you use the topography, which in Himalayas is quite steep. So you have a small reservoir, and you divert the water in a tunnel, and the tunnel is then
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			weulesday, 24 April 202
1	about the philosophy here, and the planning for the	1	only between the last 20-25 years. And he said that
2	country, and the elements that go into run-of-river and	2	many of the glaciers have melted, the track from GLOF
3	storage, so I was just thinking as you go through it	3	has reduced significantly. This is the climate effect,
4	because it's a very powerful presentation, so thank you	4	you know?
5	for that. I just haven't heard the word "climate	5	And now, instead of the 49,500 cumecs, the GLOF
6	change". Is climate change a key part of the thinking	6	event can only generate about 14-15,000 cumecs. So that
7	for some of these dams?	7	was a sigh of relief also. But there were other factors
8	DR HAYAT: Very good question, sir. Very good question,	8	that came in, and our flood was high; that is another
9	sir. Everybody is worried about	9	reason.
10	DR BLACKMORE: I have two more, but we'll do climate change	10	And the other reason for climate change is:
11	first.	11	previously the monsoons never went in the catchment area
12	DR HAYAT: Okay. I'm most glad to answer your question,	12	of Diamer Basha Dam. But in the last one decade we are
13	sir. Most welcome, sir.	13	seeing that monsoons are ingressing into the catchment
14	Yes, it is on our mind, sir. Again I'll refer back	14	of Diamer Basha Dam. And when we take that into
15	to my own project, which is the Diamer Basha Dam	15	account, the combination of snowmelt and the monsoon
16	Project. Indus is the most snowmelt-fed river in the	16	ingress actually creates the PMF, which in this case we
17	world, sir. We have more than 18,000 glaciers in that	17	calculated, with climate change added for the duration
18	area.	18	of the project, adding that 10% extra in that to take
19	When the project's feasibility was done, it was	19	care of any future climate change also, it comes out to
20	thought that the maximum flood that could be generated	20	be 42,000 cumecs. But the previous GLOF was a duration
21	in that river will be by a GLOF event. "GLOF" stands	21	of only like two days. This one is sustained over three
22	for "glacial lake outburst flood", G-L-O-F. So as the	22	weeks. So 42,000 over three weeks, and then we had to
23	glaciers melt that is their behaviour there are	23	discharge, but the discharge capacity came out to be
24	glacial lakes. And at any given point in time,	24	similar, like 35,000 cumecs, so we designed the spillway
25	a glacial lake my burst unexpectedly. And then you get	25	to that.
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1	all that flow and debris coming into the river.	1	So yes, climate change is real, it is here and we
2	So we studied that at the feasibility stage that was	2	have to take care of that. And I will talk about later
3	done in 2002, 2003 and 2004. And at that time we	3	that it is thought that in the Indus Basin, in the
4	thought that we would get a 49,500 cumecs flood because	4	Indus, we are going to see something like, people say,
5	of the GLOF. But because of the large reservoir by	5	17% reduction in the volume of water that is going to
6	the way, the reservoir here holds about 8 million	6	flow in this river, because of climate change, annually.
7	acre-feet of water, and it's 100 kilometres long. So it	7	DR BLACKMORE: So my next question: I look at this as
8	has some absorption capacity.	8	hydropower, right, hydropower potential in all of its
9	So the outflow in that flood was only about	9	forms. There are many forms, which you've discussed.
10	35,000 cumecs, the spillway capacity. So that was the	10	But over here, I see countries such as Pakistan and
11	probable maximum flood; and you'll hear more about that	11	others that are going down a journey of green power
12	in presentations 5 and 6 as we go along.	12	wind, solar and using hydropower or hydropower
13	Later then, when we were doing this construction	13	storage as an offset for the times when the wind doesn't
14	design, we were looking at what your question is,	14	blow and the sun doesn't shine. So I'm just wondering:
15	climate change. And we said: what has happened to the	15	is the background to the way we're now thinking about
16	glaciers? What has changed in the snow cover? Is there	16	this network here of opportunities, looking for what
17	anything that is required that we should change their	17	a green future might be you've got climate change,
18	design or we should have a re-look at that?	18	which you've just discussed, thanks. But I'm just
19	•		wondering about whether solar now is by far the
	So again we contacted the same professor and by	19	-
20	So again we contacted the same professor and by the way, he is Professor Reynolds; maybe you are	20	cheapest. Like in Australia, it's by far the cheapest
20 21	So again we contacted the same professor and by the way, he is Professor Reynolds; maybe you are familiar with his name. We contacted	20 21	cheapest. Like in Australia, it's by far the cheapest unit of power you can get, but [there's] not too much
20 21 22	So again we contacted the same professor and by the way, he is Professor Reynolds; maybe you are familiar with his name. We contacted Professor Reynolds, and we requested him that he carry	20 21 22	cheapest. Like in Australia, it's by far the cheapest unit of power you can get, but [there's] not too much solar at midnight. And we're looking to invest very
20 21 22 23	So again we contacted the same professor and by the way, he is Professor Reynolds; maybe you are familiar with his name. We contacted Professor Reynolds, and we requested him that he carry out this study for us. And over a few months, he did	20 21 22 23	cheapest. Like in Australia, it's by far the cheapest unit of power you can get, but [there's] not too much solar at midnight. And we're looking to invest very heavily.
20 21 22 23 24	So again we contacted the same professor and by the way, he is Professor Reynolds; maybe you are familiar with his name. We contacted Professor Reynolds, and we requested him that he carry out this study for us. And over a few months, he did that study, and he came up with a very surprising	20 21 22 23 24	cheapest. Like in Australia, it's by far the cheapest unit of power you can get, but [there's] not too much solar at midnight. And we're looking to invest very heavily.THE CHAIRMAN: What's the question?
20 21 22 23	So again we contacted the same professor and by the way, he is Professor Reynolds; maybe you are familiar with his name. We contacted Professor Reynolds, and we requested him that he carry out this study for us. And over a few months, he did	20 21 22 23	cheapest. Like in Australia, it's by far the cheapest unit of power you can get, but [there's] not too much solar at midnight. And we're looking to invest very heavily.
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1	into the planning of the budger over a large of the line	1	Vou had a third question sir?
1	into the planning of the hydropower, solar and wind.	1	You had a third question, sir?
2	DR HAYAT: Sir, we are. As you know, sir, already the	2	DR BLACKMORE: No, I'll stop, that's fine.
3	energy mix in Pakistan is skewed. And that's why our	3	PROFESSOR BUYTAERT: As a quick follow-up question on the
4	energy bills are out of the roof, you know? Normally it	4	discussion about energy storage, has Pakistan any plans
5	should be 70/30: 70% hydro ideal mix and 30%	5	for pumped hydropower?
6	other. Here, we have almost the other way round.	6	DR HAYAT: I think, to the best of my knowledge, there was
7	The problem with hydro is also it's seasonal	7	some talk of pump storage. This is one of the good
8	variation also. During high-flow season, you have	8	options that is available to any country that, during
9	enough water that you can release and generate	9	low demand, you actually use the electricity that you're
10	electricity all the way round. And that is when we	10	producing to take water up, store again. So it's
11	have, by the way, peak demand also, because those are	11	a cyclic sort of situation, pump storage: you pump the
12	the hot months in Pakistan, all the air-conditioning is	12	water back and use it for peaking.
13	going on and things like that.	13	So to my knowledge, I think the sites may be
14	But during winter months, the power-plants normally	14	an issue. But yes, that is an option that must be
15	go down to almost 30% or 25% of their capacity because	15	studied. But I'll come back to you with more
16	of the low flows; and you're storing water also for your	16	information when I get that.
17	crops and things like that. So you have to have	17	PROFESSOR BUYTAERT: Thank you.
18	something additional coming in. That is one factor	18	THE CHAIRMAN: Thank you very much. Continue, please.
19	where our other thermal and nuclear power-plants come	19	DR HAYAT: Thank you, sir.
20	in.	20	So slide 13, please. Pre-feasibility study. So
21	That being said, yes, we have the government has	21	with the basic concept in hand, the next step is to
22	a very aggressive policy of pursuing other green	22	undertake the pre-feasibility study. Now, the starting
23	alternatives. This is a green alternative also, because	23	point is, for example, a site visit to get further
24	it doesn't emit any gases or things like that,	24	data in particular, hydrology to ensure sound
25	hydropower. But in terms of wind and solar.	25	basis for the computation of future energy; more
_			
	Page 61		Page 63
1	But that being said, somebody quoted me an example	1	comprehensive data on basic layout of the hydropower,
1 2	But that being said, somebody quoted me an example from Australia. We have to be very careful when we go	1 2	comprehensive data on basic layout of the hydropower, HEP; cost-benefit analysis.
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1	So this study actually focuses mainly on these three	1	So this runs in parallel with the environmental,
2	aspects and there are other things which run in	2	social, financial, regulatory, contracting activities
3	parallel, as I said, but these are the three main	3	which I have referred before. It serves three purposes:
4	things.	4	first, it allows for further optimisation of the concept
5	And then of course you decide what further studies	5	which was developed at the feasibility stage, and each
6	are required. So a full hydrological and geological	6	element is designed to a higher degree. And it serves
7	analysis of the project site is done at this stage.	7	as a basis in which the tender drawings are made.
	Environmental studies are done to a greater extent.		•
8	6	8	This is important, because these are the drawings
9	A lot of site investigations are done: drilling, taking	9	based on which you will develop the bill of quantities,
10	samples, testing.	10	you will cost the project, and that will become a part
11	And then, with all the data that is coming in, you	11	of the tender, i.e. the drawings and the bill of
12	basically develop alternatives, which dam site will be	12	quantities, and of course the other specifications and
13	suitable. So it's not one type sometimes that suits	13	things like that, they will become part of the whole
14	every place. So you will say: should I go for a CFRD,	14	tender document which will be floated on the
15	ECRD, or should I go for a concrete dam? Is it gravity?	15	international market. The contractor will have that
16	Is it arch? All those things. Where will be the	16	information. He will look at that and then he will bid
17	powerhouse? What will be the capacity?	17	for the project.
18	So you make five, six, seven alternatives. Then you	18	So when this is done, this allows the implementer of
19	design them with a broad sort of brush to an extent and	19	this project that he can then proceed to the
20	then select, with all these things, which is the best	20	construction phase. So the engineering design is
21	alternative out of these that you can then take forward	21	actually a bridge between the design and construction.
22	in your feasibility study. So first you do a broad sort	22	And if you engage the contractor early, you can
23	of a sweep, and then you narrow down to your one or two	23	start early. And as a rule of thumb which we normally
24	preferred alternatives in this feasibility, and you then	24	use: that 1,000 MW produces electricity which is valued
25	finally go with one.	25	at \$1 million per day. So this is just a basic rule of
	Page 65		Page 67
1	So the selected alternative will be designed, and	1	thumb And so this gives you an idea that if the
$\frac{1}{2}$	So the selected alternative will be designed, and its cost estimated reasonably. That will include the	1	thumb. And so this gives you an idea that if the
2	its cost estimated reasonably. That will include the	2	project is late, how much you are losing. And if you
2 3	its cost estimated reasonably. That will include the cost of equipment and construction, and the analysis of	2 3	project is late, how much you are losing. And if you start early, you are good at design, how much money
2 3 4	its cost estimated reasonably. That will include the cost of equipment and construction, and the analysis of HEP operation strategies, a computation of expected	2 3 4	project is late, how much you are losing. And if you start early, you are good at design, how much money actually you start making as early as possible. So
2 3 4 5	its cost estimated reasonably. That will include the cost of equipment and construction, and the analysis of HEP operation strategies, a computation of expected energy production, analysis of tariff values/markets	2 3 4 5	project is late, how much you are losing. And if you start early, you are good at design, how much money actually you start making as early as possible. So people are very keen to start their project early.
2 3 4 5 6	its cost estimated reasonably. That will include the cost of equipment and construction, and the analysis of HEP operation strategies, a computation of expected energy production, analysis of tariff values/markets together with project finance alternatives; analysis of	2 3 4 5 6	project is late, how much you are losing. And if you start early, you are good at design, how much money actually you start making as early as possible. So people are very keen to start their project early. So at this point in time, only 20% of the expense
2 3 4 5 6 7	its cost estimated reasonably. That will include the cost of equipment and construction, and the analysis of HEP operation strategies, a computation of expected energy production, analysis of tariff values/markets together with project finance alternatives; analysis of social/environmental impacts, together with appropriate	2 3 4 5 6 7	project is late, how much you are losing. And if you start early, you are good at design, how much money actually you start making as early as possible. So people are very keen to start their project early. So at this point in time, only 20% of the expense has actually been made, or less than that. Actual money
2 3 4 5 6 7 8	its cost estimated reasonably. That will include the cost of equipment and construction, and the analysis of HEP operation strategies, a computation of expected energy production, analysis of tariff values/markets together with project finance alternatives; analysis of social/environmental impacts, together with appropriate mitigation strategies, which we talked about;	2 3 4 5 6 7 8	project is late, how much you are losing. And if you start early, you are good at design, how much money actually you start making as early as possible. So people are very keen to start their project early. So at this point in time, only 20% of the expense has actually been made, or less than that. Actual money starts flowing out when you go into construction. So
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1	actually a little bit of tweaking, generally speaking;	1	change the alignment of the canal with an additional
2	generally, and I'll qualify that. There is generally	2	3 million cubic metres of rock excavation. And the
3	a little bit of tweaking in design that you have done at	3	canal is now totally running on solid gabbronorite rock,
4	the tender stage, unless there are changed conditions	4	which is the main rock in that area, and so we are safe
5	which are exposed during construction, or come to light	5	in that sense.
6	during construction. Then, if they are substantial	6	Then we found out that the rock stresses in the area
7	small changes are no problem. But if they are	7	were different, and that has a major effect on the
8	substantial, then you have to change the design, and	8	orientation of the powerhouses. Previously, it was
9	this could be substantial. Like you may have to add	9	reported that the main stress in the area in the rock
10	if your hydrology tells you something, you may have to	10	was vertical. We found out: no, it is horizontal.
11	add another spillway, or increase the capacity of your	11	Vertical always told us there was something wrong there,
12	spillway.	12	vertical could not be, maximum rock stress being
13	So I'll give you three recent examples in which, at	13	vertical did not make sense. So we found out through
14	the construction stage, we had to change the design.	14	over-coring test, and all other hydraulic fracturing,
15	Going back to Mangla Dam, I'm sure you're aware it's one	15	and things like that, that it, maximum rock stress, is
16	of the largest projects. When the construction started,	16	horizontal. And based on that information, we had to
17	the designers were Binnie and Partners, and Atkins was	17	reorient our powerhouses.
18	I think the contractor.	18	And also the spillway. When we applied the
19	When they started the project, the foundation	19	earthquake forces on the dam with the excitation, we
20	revealed that the clays were sheared. Actually, from	20	found out that this spillway was previously
21	there, the concept of sheared clays and their lower	21	a crest-gated spillway. Now, we found out those gates
22	shearing resistance came into being in the area of soil	22	would not withstand the amplification: with that
23	mechanics and geotechnical engineering. And	23	amplification, they would fly off the trunnion support,
24	Professor Alec Skempton of Imperial College actually was	24	you know, basically. So we then went for an ungated
25	engaged in those studies. And because of that, because	25	spillway.
	 Dage 60		
	Page 69		Page 71
1	of the lower shoering resistones which was found during	1	Not only that but the addimentation studies that we
1	of the lower shearing resistance which was found during	1	Not only that, but the sedimentation studies that we
2	the construction phase, we had to change the design of	2	have carried out, we have mid-level outlets now for
2 3	the construction phase, we had to change the design of the dam, with much flatter slopes to make it safe.	2 3	have carried out, we have mid-level outlets now for sediment venting, that is opening in the dam body at
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-		I	
1	drawings".	1	because it can damage the foundations when the water
	-	1	because it can damage the foundations when the water
2	This shows part of the drawings of Neelum-Jhelum	2	goes over it, damage your equipment. It's very costly
3	orifice spillway, one of the drawings that was produced.	3	to fix.
4	So this is just a snapshot of that.	4	Next slide, please, 18. So this is a basic
5	Now, unless you have any questions, sir, I will	5	schematic of a hydropower project. I'm sure you will be
6	pause here, because we then move to the next part of the	6	seeing these sort of drawings quite a few times in the
7	presentation.	7	next two days. This is a dam which we put in the river
8	THE CHAIRMAN: No questions from us. This was a very	8	to create a reservoir.
9	helpful presentation. So please, I think we're on to	9	This looks very steep, but if you look at the
10	Mr Malik. Thank you very much though, Dr Hayat, it was	10	longitudinal cross-section of Neelum River, it's almost
11	very, very helpful.	11	like this: it's a very steep river. And we have got
12	DR HAYAT: Thank you, sir. You are most welcome, sir.	12	within a very short time, if you go on our reservoir,
13	MR MALIK: Mr Chairman, members of the court, good	13	you will reach the flowing river. So it's 3 kilometres
14	afternoon. It's late afternoon now.	14	and you reach the reservoir. In case of storage dams,
15	My name is Muhammad Ayub Malik. I am associated	15	you can go 100 kilometres and you still don't see the
16		16	river, it's still a reservoir.
17	We just started construction of the project when	17	We have an intake from where we take the water.
18	I joined, and I'm still here. So a lot of things have	18	I'll explain later on their functions, later on. From
19	changed, whatever he has been telling, a lot of changes,	19	there, the water is drawn into a filling basin, which
20		20	is, in our case a desander. From the desander, the
21	bit on this one.	20	water enters the headrace tunnel. This looks very
22	My presentation is in two parts. One is I will take	22	short, but in our case it's 28.5 kilometres, so it will
23	you through the basic hydroelectric components, very	22	give you a you can imagine the scale.
23	basic. My colleagues later on, at the dam site and at	23	At the end of the tunnel, we have a surge tank,
24	the powerhouse, will be telling you in details about	24 25	-
23	the powernouse, will be tening you in details about	23	which is a sort of pressure release valve so, in case of
	Page 73		Page 75
1	diana di tana	1	
1	those things.	1	a sudden closure on the tunnels, the water doesn't
2	And then I'll tell you the construction challenges	2	damage the tunnels. And from there, the water goes into
2 3	And then I'll tell you the construction challenges of building a hydropower project in this area. And this	2 3	damage the tunnels. And from there, the water goes into the penstocks, which are highly pressurised, so most of
2 3 4	And then I'll tell you the construction challenges of building a hydropower project in this area. And this will be based on the Neelum-Jhelum: pictorial things,	2 3 4	damage the tunnels. And from there, the water goes into the penstocks, which are highly pressurised, so most of the time they are steel-lined. And that is connected to
2 3 4 5	And then I'll tell you the construction challenges of building a hydropower project in this area. And this will be based on the Neelum-Jhelum: pictorial things, what are the challenges, how we managed things. As	2 3 4 5	damage the tunnels. And from there, the water goes into the penstocks, which are highly pressurised, so most of the time they are steel-lined. And that is connected to the spiral casing through an inlet valve, which is
2 3 4 5 6	And then I'll tell you the construction challenges of building a hydropower project in this area. And this will be based on the Neelum-Jhelum: pictorial things, what are the challenges, how we managed things. As Dr Tahir Hayat says, we have to come up with innovative	2 3 4 5 6	damage the tunnels. And from there, the water goes into the penstocks, which are highly pressurised, so most of the time they are steel-lined. And that is connected to the spiral casing through an inlet valve, which is another safety thing, safety valve.
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1	normally built where you have got wide valleys, because	1	basic spillway designs. One is surface spillway. That
2	they can take a lot of pressures. Concrete dams,	2	means basically there's an opening on top of the dam
3	normally you go for narrow valleys where you go for	3	with no gates there. The water, as soon as it reaches
4	concrete dams, like in our case, in the Neelum-Jhelum	4	the full pondage level, it can start flowing over the
5	River.	5	dam. The operators have no control over this water, at
6	Next, please, 20. So these are the basic three	6	what time they can release or how much they want to
7	types of dams which I just discussed. The middle one is	7	release. So this is dependent upon the flow in the
8	the basic earthen embankment dam, which is	8	river.
9	an earth-filled dam. Now, an earth-filled dam will have	9	A similar spillway, if you put a radial gate on top
10	the tendency that the water can pass through the dam and	10	of it, becomes a crest-gated surface spillway. With
11	it can damage the dam. So you put in an impervious	11	this one, the operator has got two advantages: he can
12	core, which is generally clay core, or you can have	12	control the flow going over the reservoir, over the dam
13	an asphalt core that will stop the water migrating from	13	body, and he can raise the water that is stored behind
14	upstream to the downstream side. Still some water might	14	the dam by the height of this opening, with a gate. So
15	migrate from this core, so you put in sand drains on the	15	this is the crest-gated surface spillway.
16	downstream side so that it doesn't have a catastrophic	16	And the third one is where you put the spillway deep
17	failure of the dam.	17	in the dam body. This has the advantage that you can
18	Second is your concrete dam, which can be either	18	have smaller gates because you can pass a similar amount
19	gravity dam, massive concrete, or you can have an arch	19	of water because it has got a pressure on it to pass
20	dam, which is a thin structure, but if you have strong	20	through. But it comes with its own problems: your gates
21	abutments then you can put an elliptical-shaped	21	have to be much stronger, you have to make sure that you
22	structure that can transfer the forces to the abutments.	22	don't have the velocities of water coming out are
23	The third type is your concrete-faced rockfill dam,	23	much higher, so your downstream concretes and the ogee
24	where you make the (indistinct) of crushed rock, and	24	surfaces have to be catered for that one.
25	then you put on top, on the upstream face, concrete	25	Third problem is that they, by virtue of their size,
	Page 77		Page 79
1	slabs. That will act as an impervious barrier to the	1	they are limited to the maximum design capacity. So in
1 2	slabs. That will act as an impervious barrier to the water.	1 2	they are limited to the maximum design capacity. So in case of an exceptional flood, they are then combined
	_		
2	water.	2	case of an exceptional flood, they are then combined
2 3	water. On all three sites, three types of dams, you have to put cutoff walls with it so that the water doesn't seep under the dam. Anything that can seep under the dam can	2 3	case of an exceptional flood, they are then combined with either surface spillway or a gated spillway on top,
2 3 4	water. On all three sites, three types of dams, you have to put cutoff walls with it so that the water doesn't seep under the dam. Anything that can seep under the dam can undermine the dam foundations. Their purpose is to	2 3 4	case of an exceptional flood, they are then combined with either surface spillway or a gated spillway on top, so that there's a combination of both gates, or three types of gates, for the safety of the dam. [Slide] 23, please. Now we come to the intakes.
2 3 4 5 6 7	water. On all three sites, three types of dams, you have to put cutoff walls with it so that the water doesn't seep under the dam. Anything that can seep under the dam can undermine the dam foundations. Their purpose is to elongate the seepage part so that the water that comes	2 3 4 5 6 7	case of an exceptional flood, they are then combined with either surface spillway or a gated spillway on top, so that there's a combination of both gates, or three types of gates, for the safety of the dam.[Slide] 23, please. Now we come to the intakes.The intakes are the structures through which you take
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2 3 4 5 6 7 8 9 10	 water. On all three sites, three types of dams, you have to put cutoff walls with it so that the water doesn't seep under the dam. Anything that can seep under the dam can undermine the dam foundations. Their purpose is to elongate the seepage part so that the water that comes out from the downstream side comes out a long way down the dam side in the river. 21, please. Spillways. Spillways, like the name 	2 3 4 5 6 7 8 9 10	 case of an exceptional flood, they are then combined with either surface spillway or a gated spillway on top, so that there's a combination of both gates, or three types of gates, for the safety of the dam. [Slide] 23, please. Now we come to the intakes. The intakes are the structures through which you take the water from your reservoir and you take it into the tunnels or the conveyance system. The run-of-the-river projects have a problem that they are susceptible to
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1	start migrating into your tunnels, which can damage your	1 have a 3.5-kilometre tailrace tunnel, which is
1 2	electromechanical equipment.	 nave a 5.5-kilometre tailrace tunnel, which is unpressurised or low pressurised. I won't say it's
3	For that, you go for a surface intake. In case of	 unpressurised of low pressurised. T won't say it's unpressurised, but it has got only 20 metres of head on
4	surface intake, you cannot put it too high because you	4 it.
5	can draw air in the intake. So in this case, you have	5 Next, please (27). Now I come to the turbines.
6	a separation between your tunnel intakes and the intake	6 Now, turbines are the elements that convert hydraulic
7		7 head, hydraulic power into mechanical power. Now, we
	from the reservoir, so that your clean water comes in and then you've get the water intelve coming from the	
8	and then you've got the water intake coming from the	0 11
9	tunnel.	9 Francis turbine we call the "reaction turbine", and the
10	In case you've got more silt, you can put a desander	10 Pelton we call the "impact turbines".
11	in between, which is a long settling pond for the	11 Now, in case of a Francis turbine, the water comes
12	sediment to settle down. We have got a settling pond;	12 in through the spiral casing and you see the diameter
13	you just saw a picture in Mr Joya's presentation	13 reducing gradually. That is so that the water enters
14	earlier, and we'll be showing you tomorrow those	14 through these guide vanes. The turbine sits here. This
15	settling points.	15 is during the construction. And as water goes in, it
16	Next slide (25). Now, the conveyance elements. To	16 maintains the pressure while the water keeps on getting
17 18	take water from the intake to the powerhouse, you have got tunnels, canals, and then you've got penstocks. And	in, and it hits the turbine runner and it rotates. Andthen it's connected on the top to a shaft with
		1
19 20	right next to the powerhouse, you will have this inlet	 a generator that rotates and generates electricity. Next, please (28). As I was saying, there are two
20	wall.	20 Next, please (28). As I was saying, there are two21 main types of turbines. One is the reaction turbine,
21	This is a picture of the inlet valve of our Neelum-Jhelum project. The penstock terminates here.	• I
22	1 0 1	6 1
23 24	From there, it's connected to the inlet valve, and the	23 you just saw the picture. It goes in, rotates the24 Francis runner, and then the water goes down into the
24 25	inlet valve is then connected to our scroll casing, which takes the water into the turbine.	
23	which takes the water into the turbine.	25 turbine. This whole system is pressurised. And this
	Page 81	Page 83
1	These are designed so that, in case of an emergency,	1 pressure is equivalent to the pressure you have got in
2	they can shut down. They have got these massive	2 your system; which is, in our case, 420 metres of head.
2 3	they can shut down. They have got these massive counterweights, which are 20 tonnes. So in case you	 2 your system; which is, in our case, 420 metres of head. 3 Whereas in case of a Pelton wheel, you have got
2 3 4	they can shut down. They have got these massive counterweights, which are 20 tonnes. So in case you have an electricity failure or something, they can just	 2 your system; which is, in our case, 420 metres of head. 3 Whereas in case of a Pelton wheel, you have got 4 a nozzle and a needle valve, which sprays a jet of water
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2 3 4 5 6	they can shut down. They have got these massive counterweights, which are 20 tonnes. So in case you have an electricity failure or something, they can just drop on their own under gravity. So they've got a big ball valve inside that rotates, with that load dropping	 2 your system; which is, in our case, 420 metres of head. 3 Whereas in case of a Pelton wheel, you have got 4 a nozzle and a needle valve, which sprays a jet of water 5 on these buckets or cups. And this rotates this wheel, 6 and there's a horizontal shaft connected to a generator.
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		1	
1	gates on it that regulate the flow?	1	abandoned later on.
2	MR MALIK: Yes, we have got the gates. We have got the	2	And then the surge shaft, I said 353 metres high.
3	wicket gates. We call them "wicket gates".	3	And the powerhouse. Powerhouse is a huge cavern
4	DR BLACKMORE: What do you call them?	4	that we have to go and and like Dr Tahir Hayat was
5	MR MALIK: "Wicket gates".	5	saying, there were changes. In this case, we had to
6	DR BLACKMORE: "Picket"?	6	change the orientation and the location of the
_	MR MALIK: "Wicket".	7	-
7	DR BLACKMORE: Ah, well, that's Australian!	8	powerhouse before we started excavating.
8			Next, please (32). The first one was to divert the Neelum River. This is our construction site. So to
9	MR MALIK: We got it from the British!	9	
10	DR BLACKMORE: Ah, I can't comment on that!	10	make it dry or make it free of water, we excavated
11	MR MALIK: So with that, you can adjust the opening and the	11	a diversion tunnel on the right bank, 505 metres long.
12	water that goes in, how much you want to open it. Our	12	This, you can see on the right side, is the water coming
13	turbines are at 300 rpm. They run at 300 rpm.	13	out from the diversion tunnel. On the bottom left side,
14	Next, please (29). The last element, once you	14	this is the foundation concretes for the main structure
15	generate electricity, you can't see this, the	15	of the dam.
16	3.5-kilometre tunnel that discharges the water back to	16	And incidentally, if you see this long wall, during
17	the river.	17	construction we realised that this water that we can
18	Now, this is the outlet structure. You were saying	18	divert to the river is not enough, so we'll be
19	that you might have seen it. It is visible. When you	19	overtopped, our coffer dams will be overtopped. So we
20	are travelling on the road, you can see this part,	20	came up with the idea to use this area on the right side
21	because you are travelling on top of this road. So you	21	as an open channel. And we built a longitudinal coffer
22	have seen this one.	22	dam, and put RCC, roller-compacted concrete flooring
23	So this water is then diverted back. It's conveyed	23	here, on which we'll later on build one element, which
24	back to Jhelum River. So basically the water, you can	24	was the rockfill dam on this part. Rest of them was
25	touch it. It's coming from Neelum, untouched by	25	concrete dam.
	Page 85		Page 87
	r age of		rage or
1	anything else, and now it's going into Jhelum River	1	So we used this thing, and we were able to pass
2	after 31.5 kilometres.	2	1,500 cumecs during construction, without overtopping
2 3	after 31.5 kilometres. Next, please (31). Now I'll give you a small	2 3	1,500 cumecs during construction, without overtopping our coffer dams.
2 3 4	after 31.5 kilometres. Next, please (31). Now I'll give you a small overview of the construction challenges that we have	2 3 4	1,500 cumecs during construction, without overtopping our coffer dams. Now, this left side you see is the excavation for
2 3	after 31.5 kilometres. Next, please (31). Now I'll give you a small overview of the construction challenges that we have gone through during construction of this Neelum-Jhelum	2 3 4 5	1,500 cumecs during construction, without overtopping our coffer dams.Now, this left side you see is the excavation for the desanders. And this block you see is basically the
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1		r	
1	Our tunnels, the lowest point was when we passed	1	the Jhelum crossing, they come back and they again merge
1	Our tunnels, the lowest point was when we passed	1	into one tunnel.
2	under the River Jhelum. You saw the drawing where the	2	
3	river comes in from on the inside, we call it "upper	3	These tunnels are 8-metre diameter excavated, and
4	limb"; and then it goes to Muzaffarabad, and then comes	4	then they were concrete-lined. All the tunnels which
5	back lower limb. So the tunnel came from Neelum River,	5	were done by drill and blast are concrete-lined. The
6	it went under the Jhelum River, and then it discharged	6	tunnels that were excavated with the TBM are
7	into Jhelum River. So we were around 178 metres under	7	shotcrete-lined.
8	the Jhelum River.	8	Next, please (36). This is the steel liner factory.
9	Next, please (34). Now I'll show you the profile of	9	I told you under the Jhelum River we put in the steel
10	our tunnels. This is the dam site where the Neelum	10	liner. These are 6.6-metre diameter steel pipes. We
11	River is flowing. From here, this is how our tunnels	11	used to call them "cans". And each piece was 12 metres
12	were. You see the profile of the tunnel. This part of	12	long, 72 tonnes of weight. It's 38-millimetre
13	the tunnels have a very I would say gradient is very	13	high-grade steel. And these were transported through
13	less because we used the TBMs on that. TBM has I was	13	low-bed carrier from this factory inside the tunnel
		14	
15	told that they have a restriction, or they can't go		where they were to be placed. And then they were
16	above 6% gradient, these light TBM. So the TBM	16	offloaded on a rail carriage which will take them where
17	incidentally started here, just downstream of this added	17	they were to be installed. And there, they were welded
18	A2, and we excavated up to here with the TBM tunnels.	18	together. And once they were all welded together, they
19	And you can see the overburden. At the highest point,	19	were filled up with concrete from outside.
20	it was around 1.5 kilometres of overburden on top of the	20	Next, please (37). This is the surge shaft I was
21	tunnels.	21	telling you. And for comparison, we put the
22	From here, the tunnels go in a steep slope. In the	22	Eiffel Tower along it. Eiffel Tower is 330 metres high.
23	original design, this dotted line, this was in the	23	Our surge shaft is 353 metres.
24	original concept or feasibility design, because the	24	Yesterday somebody asked me from Chicago, they were
25	tunnel engineers say that you need to have sufficient	25	doing another exercise, and they say in Scotland they
	Page 89		Page 91
1	rock cover on top of you to have a safe tunnel. So the	1	are having a pump storage where they have got a surge
1 2	rock cover on top of you to have a safe tunnel. So the designers had this thing 400 metres below the river.	1 2	are having a pump storage where they have got a surge shaft which is higher than Burj Khalifa. Burj Khalifa
2	designers had this thing 400 metres below the river.	2	shaft which is higher than Burj Khalifa. Burj Khalifa is 828 metres high, so you can imagine a surge shaft
2 3 4	designers had this thing 400 metres below the river. But with this thing, the gradients were coming out more than 14% so our electromechanical our	2 3 4	shaft which is higher than Burj Khalifa. Burj Khalifa is 828 metres high, so you can imagine a surge shaft which is 828 metres high.
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1	had less than a dozen fatalities in 12 years of	1	MR MIANA: Can you repeat the question?
2	construction, and accidental ones. And half of them	2	PROFESSOR BUYTAERT: How do you control the power output of
3	were traffic-related. Somebody drove off the bridge and	3	the generators?
4	the dumper went into the river, or somebody drove over	4	MR MIANA: The power from the generator is dependent upon
5	somebody sleeping in the tunnel. I mean, people do it.	5	the head and the flow rate. So if the flow rates are
6	It's idiotic but people still do it.	6	less then the power generation is obviously less. And
7	The main accidental deaths were I think six or	7	the controlling is through our regulation of the wicket
8	seven. Three we had an incident in the TBM, and five or	8	gates or the stairways, what you were describing over
9	six where the form work fell down.	9	here. And the rest is the governor system, which
10	Next, please (38). Now, this is the powerhouse	10	controls the system frequency, as well as the speed of
11	cavern. The powerhouse cavern, when we'll go tomorrow	11	the turbine.
12	what you will see is 50% of the powerhouse. This	12	So these are the parameters, which are
13	powerhouse is 25 metres wide, and from the top to the	13	interconnected and which control the output of the
14	deepest point is 54 metres, and the length is 137 metres	14	generator.
15	long.	15	PROFESSOR BUYTAERT: Thank you.
16	So we excavated. Starting from the top, we	16	DR BLACKMORE: I'm just interested in what was the design
17	excavated a pilot hole, started put a tunnel through	17	criteria for earthquake loading. What did you allow
18	the top, and then we took out the shoulders while we put	18	for? I'm assuming you allowed the same for the
10 19	in 15-metre long strand anchors to support the crown.	10	powerhouse, the tunnel and the structure, but I'm not
	And then we came down.	20	sure what it would be.
20			
21	When we came to this height, we put in these crane	21	MR MALIK: I have to find out. We have changed when it
22	beams. In the original design, these crane beams were	22	was tendered, this project was designed original
23	resting on concrete columns. But we said I mean, I was	23	design was done in 1996. What happened was that in 2005
24	part of that, that if we ever do it, these cranes have	24	there was a major earthquake. In 2007 the contract was
25	to wait for two years. So we decided to put these crane	25	awarded. But after they awarded the contract, based on
	Page 93		Page 95
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1	beams by putting these cranes and anchoring these crane	1	that earthquake the Government of Pakistan changed the
1 2	beams by putting these cranes and anchoring these crane beams into the rock by 15-metre-long stand anchors and	1 2	that earthquake the Government of Pakistan changed the earthquake criteria for this part of the world. It was
			· · ·
2	beams into the rock by 15-metre-long stand anchors and	2	earthquake criteria for this part of the world. It was
2 3	beams into the rock by 15-metre-long stand anchors and 7.5 metre-long rock bolts. So these crane beams are	2 3	earthquake criteria for this part of the world. It was a 7.8 magnitude earthquake. So I can get you the
2 3 4	beams into the rock by 15-metre-long stand anchors and 7.5 metre-long rock bolts. So these crane beams are designed to take a load of, I think, 600 tonnes.	2 3 4	earthquake criteria for this part of the world. It was a 7.8 magnitude earthquake. So I can get you the seismic parameters from where we changed both
2 3 4 5	 beams into the rock by 15-metre-long stand anchors and 7.5 metre-long rock bolts. So these crane beams are designed to take a load of, I think, 600 tonnes. We have two bridge cranes running on that, 275 tonnes each. At this elevation, our powerhouse, 	2 3 4 5	earthquake criteria for this part of the world. It was a 7.8 magnitude earthquake. So I can get you the seismic parameters from where we changed both underground parameters and the aboveground parameters to
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1	of experts were here. We were sitting in the design	1	At the end of the desanders is a collecting canal
2	office in Muzaffarabad and I was giving a presentation	2	from where the water goes into the tunnel; so this is
3	on the schedule of the project. And I have done hardly	3	the left-hand structure. Underneath the desanders you
4	three lines when there was a sound like there was	4	see these small gates. These are called under-sluices.
5	an accident on the road. Our building was right next to	5	This is for flushing any silt that accumulates in front
6	the main highway. And I thought there's an accident.	6	of our intake structures.
7	And I turned around and everyone has disappeared. And	7	In the middle, these are our orifice spillways.
8	then I realised that this was an earthquake.	8	These are three gates. And we have to design these
9	So I went out, and we were standing there, and you	9	gates so that in case of an emergency, even if one gate
10	can see there's a vehicle showroom right next to that	10	is out of order, these can pass the maximum flood. This
11	building, and you can see a wave going on the facade of	11	is called "N minus 1 criteria" on any dam. So these
12	that glass building, and it was for 30 seconds.	12	gates are huge. In Pakistani standards, normally our
13	Later on we found out it was a 7.4 earthquake. So	13	gates are 12 metres by 8 metres. Our standard gates on
14	when I came back, I commented: never again talk about	14	most of our projects are 12 metres by 8 metres. These
15	schedule on this project: even the earth shakes!	15	are 12 metres by 15 metres: 12 metres wide, 15 metres
16	THE CHAIRMAN: Well, again, I hope we don't test that number	16	high.
17	here. I also hope that they're not constructing the	17	Then on the right, which is under construction
18	aircraft as we're flying home!	18	you don't see it here is we call it debris
19	MR MALIK: It's already been constructed!	19	channel. This has got this is crest-mounting gates
20	THE CHAIRMAN: I had a few questions. This relates to the	20	and it's got flap gates. The radial gates, they move
21	powerhouse, but it's a very basic one. It looked like	21	like this upwards, and the water goes below that. The
22	there were at least two turbines there. How many	22	flap gates are like this and they fall down.
23	MR MALIK: Four turbines.	23	Basically, in this reservoir, in case of floods, you
24	THE CHAIRMAN: Four turbines.	24	get a lot of floating debris. And especially sometimes
25	MR MALIK: Four turbines.	25	when you've got exceptional floods, you get these logs
	Page 97		Page 99
			1 450 //
1	THE CHAIRMAN: And the value of having multiple turbines is	1	coming in because there's a big logging industry going
1 2	THE CHAIRMAN: And the value of having multiple turbines is not to use them all at once; is that correct?	1 2	coming in because there's a big logging industry going on in the upper reaches. So you get logs. So to pass
	not to use them all at once; is that correct? MR MALIK: No, if we have full water supply available, like		on in the upper reaches. So you get logs. So to pass them through this structure, you lower the gates and the
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1	subcontinent, as per the tectonics, it's going beneath	1	He's the geologist so he knows exact, but I knew that
2	the Eurasian plate and that's why Himalayas are still	2	it's around 25 metres.
3	rising.	3	DR BLACKMORE: That must be pretty good rock
4	THE CHAIRMAN: But we don't need a visa to cross from one	4	MR MALIK: Yes.
5	MR MALIK: No, no!	5	DR BLACKMORE: because I put them down 120.
6	THE CHAIRMAN: So my last question was relating to the surge	6	MR MALIK: No, we put it at 25. And then when we started
7	shaft, which I think was at slide 37. Could you just	7	raising the reservoir, for the first few months a lot of
8	indicate: the idea here is not that there would be water	8	water came up from our drainage system in the drainage
9	that would go necessarily go all the way up and out the	9	galley. But now hardly one third of that water is
10	shaft?	10	coming out, very little water comes out.
11	MR MALIK: No, no.	11	MR MINEAR: First of all, Mr Malik, Mr Hayat, thank you for
12	THE CHAIRMAN: It's just a pressure release where there	12	your presentations, they were very, very helpful.
13	might be water possibly?	13	When we drove up this morning, we were looking at
14	MR MALIK: It contains water to the level where the dam	14	the Jhelum River, and it was both more turbid and
15	water level is. Because the liquid maintains its level.	15	a higher flow than I would have expected during this
16	So it's not like there is a lot there. So even if the	16	time of year. Am I right about that or is that typical?
17	water level in the reservoir is 1,000, the water in this	17	MR MALIK: No, it's normal. Mr Tahir Hayat is working on
18	tunnel will be 1,000. It has got another snake going on	18	Indus River, which he says is fed by snowmelt.
19	top of it.	19	Similarly with the Jhelum River, but the Jhelum River we
20	But that tunnel, our reservoir level, maximum level	20	call it an "early riser". You can see the snow from the
21	is 1,015 above sea level. This shaft has a tunnel on	20	dining room.
21	top of it. That has outlet at 1,040. So the water will	21	MR MINEAR: Yes.
22	•	22	
	be at 1,015 all the way in that tunnel. When the	_	MR MALIK: Similarly you've got mountains on this side which
24	pressure comes, it's like that pump, and the water rises	24	feed into the Jhelum River, like on the inside, Srinagar
25	up in that one. And then if it is above 1,040, that	25	Valley and all that. This snow is at a lower altitude,
	Page 101		Page 103
1	turnal opens on the side of the mountain and the water	1	so it storts malting carlier
1	tunnel opens on the side of the mountain and the water	1	so it starts melting earlier.
2	goes out.	2	So in hydrological terms, the flow in the Jhelum
2 3	goes out. We have tested this phenomenon in 2019. It's part	2 3	So in hydrological terms, the flow in the Jhelum River starts rising from 15th March, that's our
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		wednesday, 24 April 2024
1	It was a 550 MW. This was in the feasibility studies.	
2	And then there was another weir there that will take it	
3	and bring it here, another 250 or something like that.	
4	Later on there was another study, like Dr [Hayat]	
5	said, that you keep on refining your inventory. And	
6	they said that instead of having these two powerhouses,	
7	you make one and you can get 969 MW here; and you put	
8	another weir upstream of our Jhelum dip, and then you	
9	have the Kohala hydropower project that generates	
10	another 1,150 MW. So instead of having 1,000 MW, you	
11	are now getting 2,000-plus MW.	
12	THE CHAIRMAN: More head, basically, yes.	
13	MR MALIK: Yes.	
14	THE CHAIRMAN: Okay. Well, thank you very much, Mr Malik,	
15	for your presentation. Thank you, Dr Hayat, for your	
16	presentation. They were very helpful and very	
17	informative. Thank you as well to Mr Miana for jumping	
18	in in the midst to answer a question. We very much	
18	appreciate all the work you put into these	
20	presentations.	
20	I think that brings us to the end of today's	
21	session, so we will retire now, but with thanks to	
23 24	everyone who's present. We very much appreciate all the	
	work you've put into this, and we're looking forward to	
25	the next few days as well. Thank you very much.	
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