Hydrology: Long-term Risk, Short-term Data

Briefing for Fields Institute Workshop

Presented by:

Andrew Lin &
Chris Gifford

August 11, 2014

Introduction

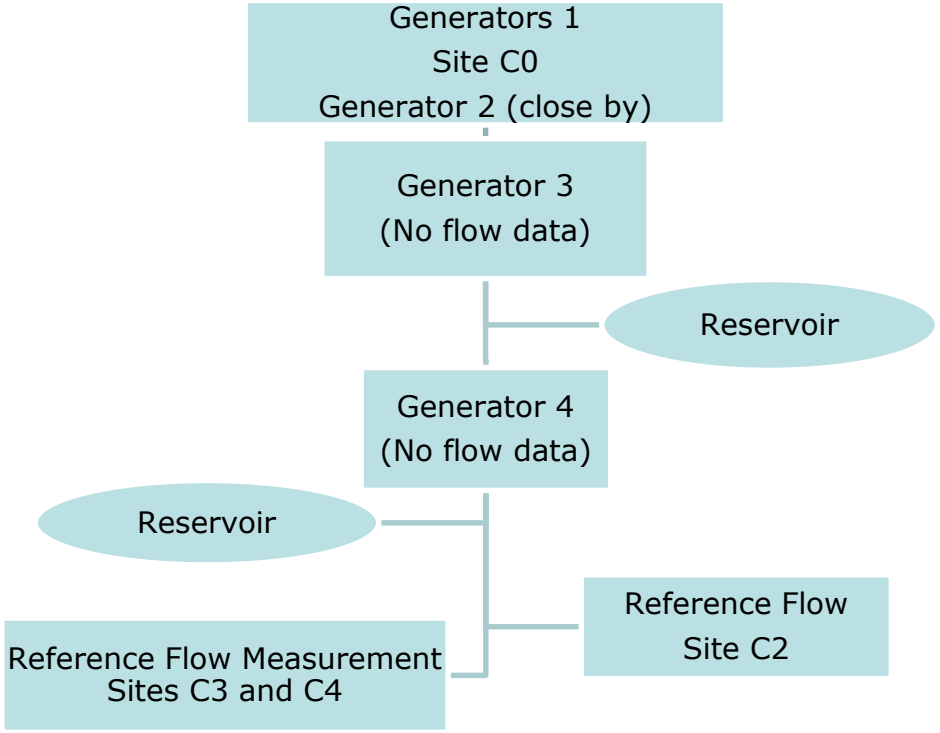
- Who are we and what do we do?
  - DBRS is a credit rating agency, it provides public and private credit ratings on Project Finance (i.e. non-recourse) bonds.
  - A significant business area is rating renewable energy projects, most of which are hydro-electric and some are wind or solar powered.
- People
  - Andrew Lin is a Managing Director of DBRS, leading the Project Finance team
  - Chris Gifford is a credit analyst in DBRS, rating Project Finance transactions

Hydro-electric Power Generation

- Two main types of project:
  - Run-of-river – water diverted from and immediately returned to a flowing river to generate at a single station
  - Stored-series*: multiple stations along a river system with flow often seasonally controlled by dams and reservoirs
- Debt Investors' Perspective
  - Fixed repayments to be made in each year
  - Non-recourse to owner, the project is sole source of repayment
  - Investment-grade: <1.0% (approx.) annual probability of default on debt obligations

* Not a technical term

Stored-Series Project



Challenge

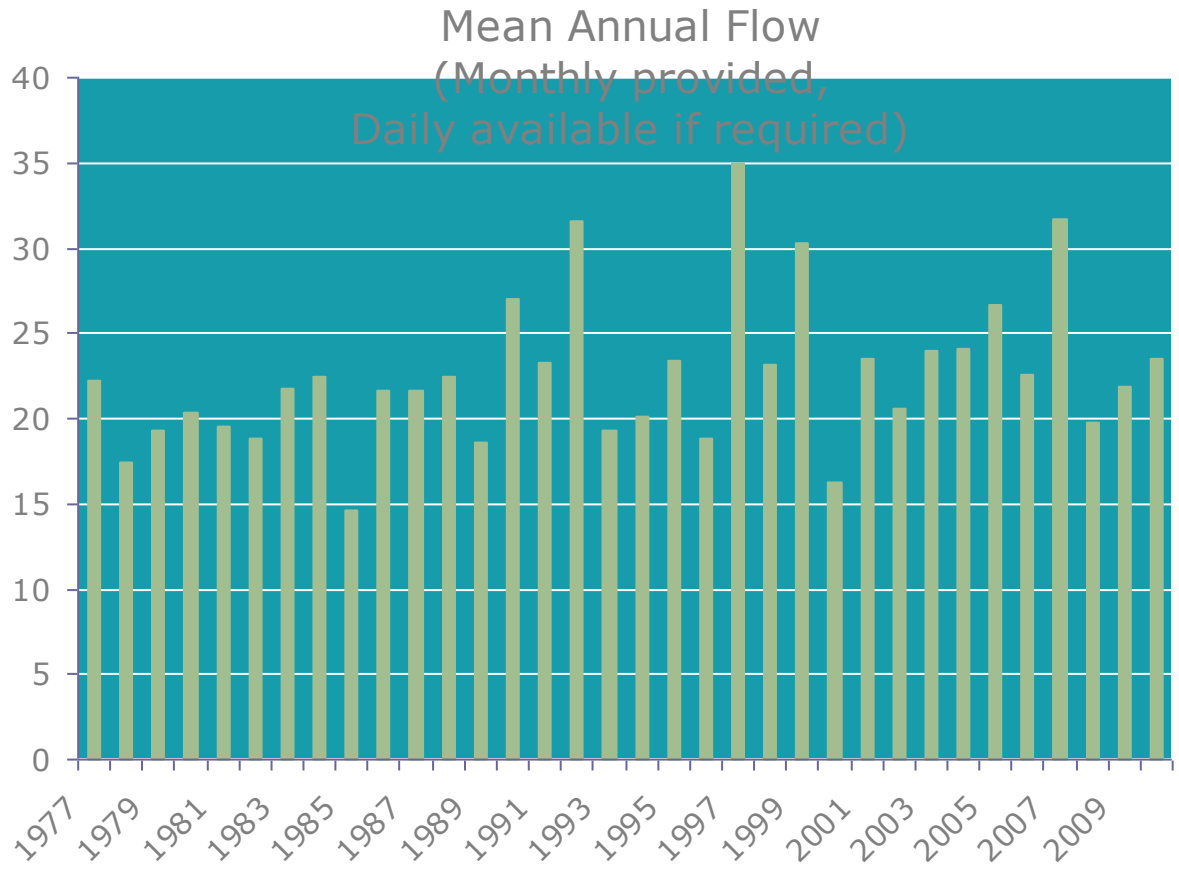
- Hydrological data characteristics
  - Hydrologist's report is available, focused on characterizing "Long Term Average Generation" – in contrast to DBRS perspective of downside scenario
  - Based on ~20-30 years of data, either in-stream measurements or nearby "reference" sites

- Implications:
  - Low water resource means less cash flow and less ability to repay debt investors
  - Downside (one-sided) tail of hydrology behavior is not likely to have been observed and fully understood

More Details

- Timing
  - Cash flow and hence hydrology available in one year (or four consecutive quarters) is relevant for debt repayment
  - In-stream flow records often available for daily and monthly mean flows – focus remains on one year period
  - Periods of flow records rarely exceed 30 years, in some cases reach 100 years
- Complications:
  - Run-of-river projects rely on instantaneous flow, stored-series projects generally manage on seasonal basis - hence assume no year-to-year storage
  - Period of long term reference data sets may not overlap with project's in-stream data

Example Data Available – time series



Example Data Available

Straight line distances between measurement points,
A0 is power generation site of interest.

km	A0	A1	A2	A3	A4	A5	A6	DRAINAGE km2	FULL YEARS	START	END
A0	0.00	2.45	7.06	15.93	16.69	30.74	49.53	259	33	1977	2010
A1	2.45	0.00	4.62	14.17	18.03	33.17	51.75	269	14	1957	1970
A2	7.06	4.62	0.00	11.23	21.36	37.80	55.85	290	15	1927	1941
A3	15.93	14.17	11.23	0.00	32.16	44.66	57.83	1760	13	1926	1938
A4	16.69	18.03	21.36	32.16	0.00	25.15	50.97	365	37	1974	2010
A5	30.74	33.17	37.80	44.66	25.15	0.00	27.85	783	22	1990	2011
A6	49.53	51.75	55.85	57.83	50.97	27.85	0.00	178	52	1959	2010

Monthly average flows (m3/s) at each measurement point

A1	Flow
09/01/1957	10.3
10/01/1957	6.17
11/01/1957	14.1
02/01/1958	25.2
03/01/1958	13.1
04/01/1958	11.4
05/01/1958	16.2
06/01/1958	10.6
07/01/1958	1.93
08/01/1958	1.45
09/01/1958	9.64
10/01/1958	27.6
11/01/1958	16.5
03/01/1959	15.1

Other contextual data (if required):

- Whether measurement points are on the same river
- Whether some low flow periods are immaterial for power generation

Data Availability

Not-for-this week: relationship between flow and energy generation, details of storage management, near-term predictions.

- Run-of-river:
  - **Nine data sets of multiple proximate measurement points**
  - one data set that includes in-stream flow data for one power station site and six reference sites
  - one data set that includes very limited power generation data (not exactly same as flow) and ten reference sites all on different river systems
- Stored-series
  - one data set including in-stream flow for a power station, four reference sites in same river system and two for adjacent river system

- Data available:
  - In-stream flow series, monthly for up to 92 years
  - Reference sites (nearby rivers or at different points on the same river) are not always concurrent

Project Rationale & Expectations

- No academic or practitioner literature found dealing with extreme low flow probability (only peak flood levels)

- Run-of-river question: With limited data, how can a 1% annual probability event be characterized?
- Stored-series question: multiple stations are used to service a single debt, so can a single view be taken?

There is no perfect data or solution: DBRS seeks reasonableness and consistency of approach.

Contact Information

Andrew Lin – MD, Project Finance, Global Corporates
+1 416 597 7453
andrew.lin@dbrs.com

Chris Gifford – VP, Project Finance, Global Corporates
+1 416 597 7398
+44 7980 80410 (U.K.) (11, 12, 14 & 15 August only)
cgifford@dbrs.com

www.dbrs.com